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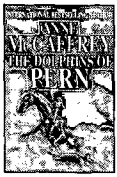

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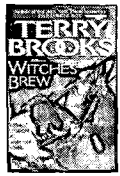

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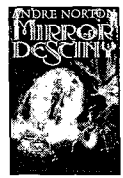

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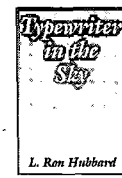

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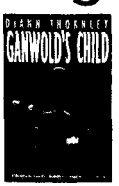

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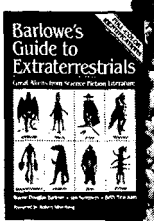

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130

Vol. CXV No.12
October 1995

Next Issue on Sale
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Serials

CETAGANDA (Part One of Four), Lois McMaster Bujold ____ 14

Novelettes

SAM BOONE AND THE THERMAL COUPLE, Bud Sparhawk ____ 106
THE WELLNESS PLAGUE, Robert R. Chase ____ 130

Science Faot

AT LAST: COMPUTERS THAT DO MATH!, Joseph P. Martino ____ 77

Short Stories

THE LENS OF TIME, James Gunn ____ 92

Probability Zero

SENTIMENTAL VALUE, Michael A. Burstein ____ 89

Reader's Departments

THE EDITOR'S PAGE ____ 4
THE ALTERNATE VIEW, John G. Cramer ____ 101
IN TIMES TO COME ____ 128
BIOLOG, (Tina Lee) ____ 129
THE REFERENCE LIBRARY, Tom Easton ____ 162
BRASS TACKS ____ 169
UPCOMING EVENTS, Anthony Lewis ____ 176

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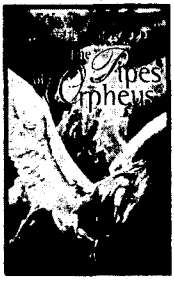

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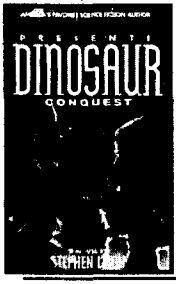

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ACHIEVEMENT TEST

Some months ago, the conversation at a dinner I was attending turned to the subject of dolphin intelligence. One participant, having done some research on the subject, said he suspected that dolphins were the most intelligent animals on the planet, with humans placing second. His suspicion was based largely on such considerations as the bandwidth available to dolphins and other creatures (such as ourselves) for communication, but that isn't really important to the question I want to look at today (for which dolphins are merely a convenient illustration).

What *is* important is the question that was raised by another gentleman on hearing the first gentleman's claim about dolphins. "But if they're so intelligent," the second gentleman wondered, "why have they *done* so little?"

To which my reply was, "How do you know they have?"

He figured that if dolphins were as intelligent as some people suspect, we might see, for example, dolphin "congresses" at which many dolphins gather to compare notes on whatever they've been applying their intelligence to. I retorted that there was room for doubt about whether, say, the U.S. Congress was evidence of human intelligence.

That remark was at least semi-facetious, but on a more serious level, it might be quite unfair to judge one species' intelligence by whether it has indulged in activities favored by another species. It might be like a poet trying to judge an engineer's intelligence by her ability to compose poetry, or the engineer judging the poet by his command of differential equations. Admittedly people often do that sort of thing, but that doesn't mean that they *should*.

I don't propose to answer the question of dolphin intelligence, but would like to look at the more general question, long a staple of science fiction and potentially a real problem of future explorers, of how you recognize intelligence when you see it. A common test is looking for artifacts and institutions comparable to our own, but this requires caution. Cultural anthropology suggests wariness

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about applying such tests even across cultures of a single species.

Very few human cultures, for instance, have independently developed high technologies. For many years, this led most people in highly technological cultures in temperate latitudes to proclaim their own self-evident superiority to less technological peoples in tropical climates. Some of them still haven't outgrown that delusion, despite abundant evidence to the contrary. Assuming that people in middle latitudes are smarter than those in the tropics simply because they have more gadgets ignores the fact that tropical cultures have less motivation—less incentive—to develop elaborate technologies. People's basic intelligence equipment covers about the same range all over the world, but what they *do* with it depends on what kinds of problems they have to deal with and what materials they have to work with.

So as human researchers try to gauge the intelligence of their neighbors, such as dolphins, whales, and apes, their task is far from simple. If their spiritual (and technological) descendants someday try to do the same for the natives of whole new worlds, it's likely to be still more challenging. There are at least two main reasons for the difficulty:

(1) Not all achievements have to look like ours.

(2) Whether a culture creates any particular type of artifact or institution depends on several factors *besides* intelligence.

It's hard to recognize achievements that grow from different ambitions than your own, simply because you haven't been taught to recognize them and you have been taught to regard certain achievements of your own culture as measures of Culture. People brought up in cities tend to look for cities, or at least villages, as primary signs of intelligence in others, and to assume that intelligence must be lacking when they are absent. But cities are a relatively late development in human history, and incompatible with some of the many ways of life developed by human intelligence. Some peoples are still nomadic, yet have highly developed cultures. Those cultures *can't* include cities, though, or even much "homegrown" technology. When you're constantly moving and have to carry everything you own, there's a strong motivation *not* to own a lot of things or spend much time making them.

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You may *use* some forms of technology, like cooking pots, but are less likely to make them yourself than to buy them from a more settled culture.

Our present culture has a huge body of written literature, and tends to look down on cultures that don't. This is a bit ironic, since our written literature grew out of an extensive *oral* tradition including such things as the ancient Greek epics that are still regarded as classics—and were not written down until long after they were created and first circulated. In the not too distant future, art and literature may exist primarily as various forms of electronic hypermedia. If that state of affairs persists long enough, it's easy to imagine our descendants assuming that intelligent beings *must* have such things, and dismissing as "savages" any who don't.

On the other hand, it's worth remembering that the fact that we *ever* developed writing or hypermedia depended on our having dexterous hands. Other species might lack those, yet have intelligence fully comparable to our own. Such species *couldn't* build cities or saxophones, or write letters or editorials, but might still create a highly advanced culture—a system of shared knowledge and beliefs—by developing an oral tradition to a level that our ancestors never bothered with because writing made it unnecessary.

Some suspect that at least some whales or dolphins may have already done that, or be in the process, here on Earth. If not, something like them

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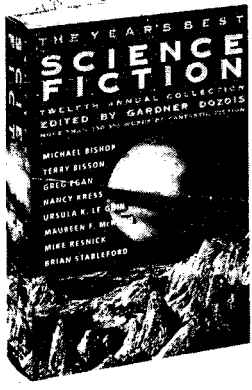

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may have done it elsewhere. And it's too much to assume that such a culture would have to include "congresses." Not all species may share the human propensity for Meetings, and some may have other methods of interacting that make such things unnecessary. Whale songs, for example, carry for such enormous distances underwater that whales or "whaloids" could communicate with others over a large part of the planet without ever having to meet face-to-face.

So in evaluating intelligence, or looking for it, we must bear in mind that the achievements of others may be qualitatively different from ours, and therefore hard for us to recognize. We must also remember that whether or not a species *has* done a particular thing does not automatically tell us whether it *could*. Intelligence does not automatically do everything for which it has the potential, and it does not *immediately* do everything it might do *eventually*. What it actually does can depend on numerous other factors, such as the following:

(1) *Physical capability*. As I mentioned in connection with cetaceans, technology depends on having not only the mental processing power to imagine things that *could* be done or made, but also the physical means to carry them out. In our case this means hands; in general, it means one or more kinds of manipulators with strength and dexterity to do a wide range of tasks. Lobsters have manipulators, but they're fairly crude; at least one opposable digit makes a huge difference in what a manipulating member can do.

Physical capability implies not just a suitable body, but a suitable environment. Even if dolphins or their heirs found a way to manipulate things (I have an idea along those lines, but I'm not going to tell you what it is!), they would still find it very difficult to do many things that are integral to human civilization. Much of our technology depends on fire, and that's not practical underwater.

Our technology also depends on having and refining certain kinds of materials, such as metals and semiconductors. On a planet of an early-generation star, metals might be too scarce to play an important role in building a civilization. That might not mean that its inhabitants couldn't develop one, but only that they'd have to find other ways. Remember Theodore L. Thomas's story "Ceramic Incident" (*Astounding*, October 1956)? The xenoarcheologists were about to abandon a planet as uninteresting since its former inhabitants had nothing more "advanced" than ceramics—until they realized that artifacts spaced hundreds of miles apart were "Burma-Shave" signs meant to be read at very high speed. . . .

This line of speculation suggests an interesting variant. Our technology includes many things that some other species couldn't duplicate because of limitations in their own physiques or available resources. What kinds of things might some of *them* be able to do that *we* couldn't because of *our* limitations?

(2) *Motivation*. Humans often respond to advice or criticism with a

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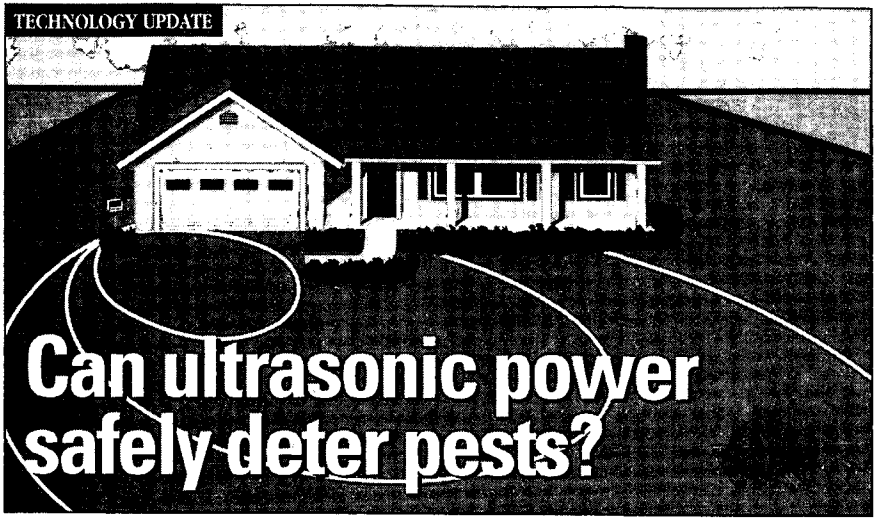

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retort like, "If you're so smart, why aren't you rich?" They may find it hard to grasp the fact that some people don't place a high value on getting rich, but some very intelligent people don't. Part of what intelligent beings choose to do will be a matter of taste, both individual and cultural.

Some individual humans seem to have a built-in drive to acquire as much material wealth or power over others as they can, and have no interest in watching sunsets or writing poetry or music. Others are quite the opposite. Some of this seems to be a matter of individual make-up, but it's very hard to separate that from cultural pressures that push individuals toward particular goals. Those pressures operate on several levels, and not always in the same direction. A culture as a whole, for example, might be heavily geared toward striving for financial success; but some families within that culture may encourage their offspring to set other priorities. In any case, what today's cultures do depends to a considerable extent on what yesterday's cultures made them.

Motivations based on what people or cultures *like* to do, of course, can only be indulged after they've attended to those based on what they *must* do. If some members of a species evolved in a mild tropical region are forced by population pressures or climate changes to survive in a region with harsh weather variations, they *will* learn to make good clothing and heated shelters—or they won't make it. If some of their fellows remain in the mild tropical climate, they probably won't do these things—not because they couldn't, but because they have no reason to.

Some people (members of harsh-climate populations, by a remarkable coincidence) have claimed that the rigors of their climate have caused them to evolve higher intelligence than others on this planet. Such arguments have been, at best, unconvincing. It's not inconceivable that such an effect could occur somewhere (something like it may have contributed to the original emergence of intelligence in our species), but our "recent" harsh climates seem not to have *changed* intelligence significantly, but to have forced their inhabitants to *use* their intelligence in new ways.

If you ask why the ability would have evolved in people who didn't need to use it, I must remind you of the difference between intelligence and instinct. Your question would be valid *if* we were dealing with instinctive behavior patterns evolved to work under different climatic conditions. Intelligence is fundamentally different; it's a highly *generalized* set of abilities that can be adapted—and enable its owner to adapt—to a wide range of circumstances. Instinct is like a single (and usually fairly simple) computer program to do a single specialized task. Intelligence is more like the hardware and operating system of the computer itself. It can run a very wide range of flexible and versatile applications, and it makes no sense to say the *computer* is no good because you want it to crunch numbers and the only application it currently has

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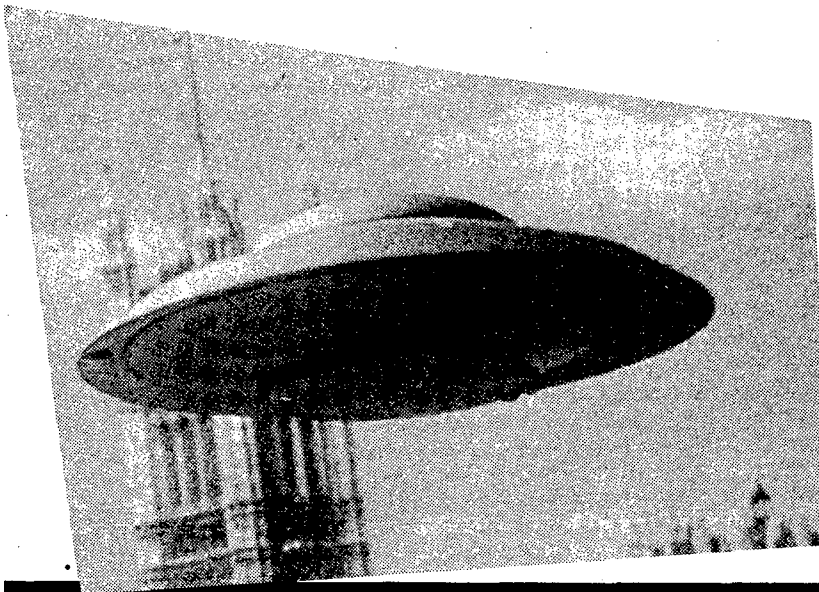

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open is a word processor. Its strength is its ability to run different *kinds* of applications, once it has "learned" them.

For years it was assumed that apes were inherently incapable of using language, because attempts to teach them to speak human languages achieved virtually nothing. In recent years that view was provisionally revised because of new experiments suggesting that the apes' failure to learn spoken language was a simple matter of lack of physical ability: they didn't have the vocal equipment to make human speech sounds. Experiments with manual sign language and symbolic keyboards seemed considerably more productive, though the experiment designs were subject to criticism and the results controversial. Still more recent studies by Sue Savage-Rumbaugh (see the book *Kanzi* by her and Roger Lewin, published by Wiley in 1994) use fundamentally different approaches and suggest strongly that apes do have the mental machinery to understand and communicate with language, but don't actually use it that way until immersed in an environment that stimulates them to do so.

Which leads to my final consideration in what must be added to intelligence to produce clear manifestations. . . .

(3) *Time*. Evolutionary evidence suggests that human intelligence has not changed very much in a very long time. Our species has probably existed for something on the order of a million years. Writing and recorded history go back a mere 6000 or so, printing presses 600, much of present science and technology a mere couple of centuries or less. Now consider an alien explorer capable of traveling freely in space and time. If he came to Earth at a randomly selected time during humanity's total existence to date, and used one of those achievements as a criterion for judging whether we're intelligent, the *maximum* probability that we would pass the test is a few percent.

Perhaps we would do well to keep that in mind in assuming that other beings, either ones that share our planet now or ones that we might meet on another in the future, must demonstrate certain achievements before we consider them intelligent. Intelligence is a far subtler thing than that, immensely valuable and immensely hard to gauge. Its essence is *potential*—and whether that potential has led to any particular manifestation depends on many other things. No specified touchstone will be produced, even by a species quite capable of imagining it, unless that species also has the physical capabilities and resources needed to realize it. It still won't occur until they see a *reason* to realize it. That may stem from physical necessity or extrapolation from earlier achievements—and either way, it may take a long, long time to come about. So while some kinds of visible achievement will almost certainly signal intelligence, their *absence* may tell us very little. ■

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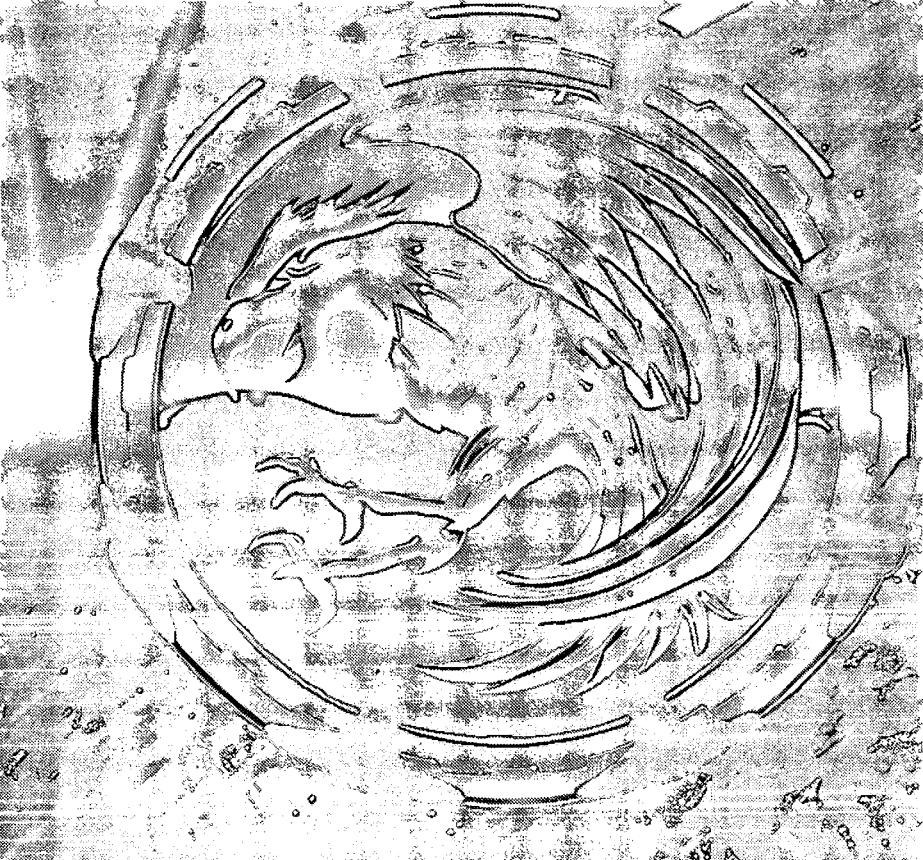

Part One of Four

Lois McMaster Bujold

CETAGANDA

Social forms have always been inextricably bound up with the most basic aspects of life. And when those change . . .

Illustration by Mike Capelotti

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PART ONE

CHAPTER ONE

Now is it, 'Diplomacy is the art of war pursued by other men,' " said Ivan, "or was it the other way around? 'War is Diplo—' "

"' All Diplomacy is a continuation of war by other means.'" Miles intoned. "Chou En Lai, Twentieth Century, Earth."

"What are you, a walking reference library?"

"No, but Commodore Tung is. He collects Wise Old Chinese Sayings, and makes me memorize 'em."

"So was old Chou a diplomat or a warrior?"

Lieutenant Miles Vorkosigan thought it over. "I think he must have been a diplomat."

Miles's seat straps pressed against him as the attitude jets fired, banking the personnel pod in which he and Ivan sat across from each other in lonely splendor. Their two benches lined a short fuselage. Miles craned his neck for a glimpse past the pod pilot's shoulder at the planet turning below them.

Eta Ceta IV, the heart and homeworld of the sprawling Cetagandan empire. Miles supposed eight developed planets and an equal fringe and allied and puppet dependencies qualified as a sprawl in any sane person's lexicon. Not that the Cetagandan ghem-lords wouldn't like to sprawl a little farther, at their neighbors' expense, if they could.

Well, it didn't matter how huge they were, they could only put military force through a wormhole jump one ship at a time, just like everybody else.

It was just that some people had some damned *big* ships.

The colored fringe of night slid around the rim of the planet as the personnel pod continued to match orbits from the Barrayaran Imperial courier vessel they had just left, to the Cetagandan transfer station they were approaching. The nightside glittered appallingly. The continents were awash in a fairy dust of lights. Miles swore he might read by the glow of the civilization, as if from a full moon. His homeworld of Barrayar seemed suddenly a dull vast swatch of rural darkness, with only a few sparks of cities here and there. Eta Ceta's high-tech embroidery was downright . . . gaudy. Yes, overdressed, like a woman weighted down with too much jewelry. Tasteless, he tried to convince himself. *I am not some backcountry hick. I can handle this. I am Lord Vorkosigan, an officer and a nobleman.*

Of course, so was Lieutenant Lord Ivan Vorpatril, but the fact did not fill Miles with confidence. Miles regarded his big cousin, who was also craning his neck, eyes avid and lips parted, drinking in their destination below. At least Ivan looked the part of a diplomatic officer, tall, dark-haired, neat, an easy smile permanently plastered on his handsome face. His fit form filled his officer's undress greens to perfection. Miles's mind slid, with the greased ease of old bad habit, to invidious comparison.

Miles's own uniforms had to be hand-tailored to fit, and insofar as possible disguise, the massive congenital

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defects that years of medical treatments had done so much to correct. He was supposed to be grateful that the medicos had done so much with so little. After a lifetime of it he stood four-foot-nine, hunchbacked and brittle-boned, but it beat being carried around in a bucket. Sure.

But he *could* stand, and walk, and run if need be, leg braces and all. And Barrayaran Imperial Security didn't pay him to be pretty, thank God, they paid him to be smart. Still, the morbid thought did creep in that he had been sent along on this upcoming circus to stand next to Ivan and make him look good. ImpSec certainly hadn't given him any more interesting mission, unless you could call Security Chief Illyan's last curt ". . . and stay out of trouble!" a secret assignment.

On the other hand, maybe Ivan had been sent along to stand next to Miles and make him *sound* good. Miles brightened slightly at the thought.

And there was the orbital transfer station, coming up right on schedule. Not even diplomatic personnel dropped directly into Eta Ceta's atmosphere. It was considered bad etiquette, likely to draw an admonition administered by plasma fire. Most civilized worlds had similar regulations, Miles conceded, if only for purposes of preventing biological contaminations.

"I wonder if the Dowager Empress's death was really natural?" Miles asked idly. Ivan, after all, could hardly be expected to supply the answer. "It was sudden enough."

Ivan shrugged. "She was a generation older than Great Uncle Piotr, and he was old since forever. He used to unnerve the hell out of me when I was a kid. It's a nice paranoid theory, but I don't think so."

"Illyan agrees with you, I'm afraid. Or he wouldn't have let *us* come. This could have been a lot less dull if it had been the Cetagandan emperor who'd dropped, instead of some tottering little old haut-lady."

"But then we would not be here," Ivan pointed out logically. "We'd both be on duty hunkering down in some defensive outpost right now, while the prince-candidates' factions fought it out. This is better. Travel, wine, women, song—"

"It's a State *funeral*, Ivan."

"I can hope, can't I?"

"Anyway, we're just supposed to observe. And report. What or why, I don't know. Illyan emphasized he expects the reports in writing."

Ivan groaned. "How I spent my holiday, by little Ivan Vorpatril, age twenty-two. It's like being back in school."

Miles's own twenty-third birthday would be preceding Ivan's soon. If this tedious duty ran to schedule, he should actually be back home in time for a celebration, for a change. A pleasant thought. Miles's eyes glinted. "Still, it could be fun, embroidering events for Illyan's entertainment. Why should official reports always have to be in that dead dry style?"

"Because they're generated by dead dry brains. My cousin, the frustrated dramatist. Don't get too carried away. Illyan has no sense of humor, it would disqualify him for his job."

"I'm not so sure. . . ." Miles

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watched as the pod wove through its assigned flight path. The transfer station flowed past, vast as a mountain, complex as a circuit diagram. "It would have been interesting to meet the old lady when she was still alive. She witnessed a lot of history, in a century and a half. If from an odd angle, inside the haut-lords' seraglio."

"Low-life outer barbarians like us would never have been let near her."

"Mm, I suppose not." The pod paused, and a major Cetagandan ship with the markings of one of the outplanet governments ghosted past, on and on, maneuvering its monstrous bulk to dock with exquisite care. "All the haut-lord satrap governors—and their retinues—are supposed to be converging for this. I'll bet Cetagandan imperial security is having fun right now."

"If any two governors came, I suppose the rest have to show up, just to keep an eye on each other." Ivan's brows rose. "Should be quite a show. Ceremony as Art. Hell, the Cetagandans make blowing your nose an art. Just so they can sneer at you if you get the moves wrong. One-upsmanship to the nth power."

"It's the one thing that convinces me that the Cetagandan haut-lords are still human, after all that genetic tinkering."

Ivan grimaced. "Mutants on purpose are mutants still." He glanced down at his cousin's suddenly stiff form, cleared his throat, and tried to find something interesting to look at out the canopy.

"You're so diplomatic, Ivan," said Miles through a tight smile. "Try not to start a war single . . . mouthed, eh?" *Civil or otherwise.*

Ivan shrugged off his brief embarrassment. The pod pilot, a Barrayaran tech-sergeant in black fatigues, slid his little ship neatly into its assigned docking pocket. The view outside shrank to blank dimness. Control lights blinked cheery greetings, and servos whined as the flex-tube portals matched and locked. Miles snapped off his seat straps just a shade more slowly than Ivan, pretending disinterest, or savoir faire, or something. No Cetagandan was going to catch him with his nose pressed to the glass like some eager puppy. He was a Vorkosigan. His heart beat faster anyway.

The Barrayaran ambassador would be waiting, to take his two high-ranking guests in hand, and show them, Miles hoped, how to go on. Miles mentally reviewed the correct greetings and salutations, and the carefully memorized personal message from his father. The pod lock cycled, and the hatch on the side of the fuselage to the right of Ivan's seat dilated.

A man hurtled through, swung himself to a sudden halt on the hatch's handlebar, and stared at them with wide eyes, breathing heavily. His lips moved, but whether with curses, prayers, or rehearsals Miles wasn't sure.

He was elderly but not frail, broad-shouldered and at least as tall as Ivan. He wore what Miles guessed was the uniform of a station employee, cool gray and mauve. Fine white hair wisped over his scalp, but he had no facial hair at all on his shiny skin, neither beard nor eyebrows nor even

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down. His hand flew to his left vest, over his heart.

"Weapon!" Miles yelled in warning. The startled pod pilot was still snaking his way clear of his seat straps, and Miles was physically ill-equipped to jump anyone, but Ivan's reflexes had been honed by plenty of training, if not actual combat. He was already moving, rotating around his own hand-hold point-of-contact and into the intruder's path.

Hand to hand combat in free fall was always incredibly awkward, due in part to the necessity of having to hang on tightly to anybody one wanted to seriously hit. The two men quickly ended up wrestling. The intruder clutched wildly, not at his vest but at his right trouser pocket, but Ivan managed to knock the glittering nerve disruptor from his hand.

The nerve disruptor tumbled away and whanged off the other side of the cabin, now a random threat to everyone aboard. Miles had always been terrified of nerve disruptors, but never before as a projectile weapon. It took two more cross-cabin ricochets for him to snatch it out of the air without accidentally shooting himself or Ivan. The weapon was undersized but charged and deadly.

Ivan had meanwhile worked around behind the old man, attempting to pinion his arms. Miles seized the moment to try to nail down the second weapon, dragging open the mauve vest and going for that lump in the inner pocket. His hand came away clutching a shock stick.

The man screamed and wrenched violently. Greatly startled and not at all sure what he'd just done, Miles launched himself away from the struggling pair and ducked prudently behind the pod pilot. Judging from that mortal yell Miles was afraid he'd just ripped out the power pack to the man's artificial heart or something, but he continued to fight on, so it couldn't have been as fatal as it sounded.

The intruder shook off Ivan's grip and recoiled to the hatchway. There came one of those odd pauses that sometimes occurred in close combat, everyone pausing for breath in the rush of adrenaline. The old man stared at Miles with the rod in his fist; his expression altered from fright to—was that grimace a flash of triumph? Surely not. Demented inspiration?

Outnumbered now as the pilot joined the fray, the intruder retreated, tumbling back out the flex tube and thumping to whatever docking bay deck lay beyond. Miles scrambled after Ivan's hot pursuit just in time to see the intruder, now firmly on his feet in the station's artificial gravity field, land Ivan a blow to his chest with a booted foot that knocked the younger man backward into the portal again. By the time Miles and Ivan had disentangled themselves, and Ivan's gasping became less alarmingly disrupted, the old man had vanished at a run. His footsteps echoed confusingly in the bay. Which exit—? The pod pilot, after a quick look to assure that his passengers were temporarily safe, hurried back inside to answer his comm alarm.

Ivan regained his feet, dusted himself off, and stared around. Miles did

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too. They were in a small, dingy, dimly lit freight bay.

"Y'know," said Ivan, "if that was the customs inspector, we're in trouble."

"I thought he was about to draw on us," said Miles. "It looked like it."

"You didn't see a weapon before you yelled."

"It wasn't the weapon. It was his eyes. He looked like someone about to try something that scared him to death. And he did draw."

"*After* we jumped him. Who knows what he was about to do?"

Miles turned slowly on his heel, taking in their surroundings in more detail. There wasn't a human being in sight, Cetagandan, Barrayaran, or other. "There's something very wrong here. Either he wasn't in the right place, or we weren't. This musty dump can't be our docking port, can it? I mean, where's the Barrayaran ambassador? The honor guard?"

"The red carpet, the dancing girls?" Ivan sighed. "You know, if he'd been trying to assassinate you, or hijack the pod, he should have come charging in with that nerve disruptor already in his hand."

"That was no customs inspector. Look at the monitors." Miles pointed. Two vid-pickups mounted strategically on nearby walls were ripped from their moorings, dangling sadly down. "He disabled them before he tried to board. I don't understand. Station security should be swarming in here right now. . . . D'you think he wanted the pod, and not us?"

"You, boy. No one would be after me."

"He seemed more scared of us than we were of him." Miles concealed a deep breath, hoping his heart rate would slow.

"Speak for yourself," said Ivan. "He sure scared *me*."

"Are you all right?" asked Miles belatedly. "I mean, no broken ribs or anything?"

"Oh yeah, I'll survive. You?"

"I'm all right."

Ivan glanced down at the nerve disruptor in Miles's right hand, and the rod in his left, and wrinkled his nose. "How'd you end up with all the weapons?"

"I . . . don't quite know." Miles slipped the little nerve disruptor into his own trouser pocket, and held the mysterious rod up to the light. "I thought at first this was some kind of shock stick, but it's not. It's something electronic, but I sure don't recognize the design."

"A grenade," Ivan suggested. "A time-bomb. They can make them look like anything, y'know."

"I don't think so—"

"My lords," the pod pilot stuck his head through the hatch. "Station flight control is ordering us not to dock here. They're telling us to stand off and wait clearance. Immediately."

"I *thought* we must be in the wrong place," said Ivan.

"It's the coordinates they gave me, my lord," said the pod pilot a little stiffly.

"Not your error, Sergeant, I'm sure," Miles soothed.

"Flight control sounds very forceful." The sergeant's face was tense. "Please, my lords."

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Obediently, Miles and Ivan shuffled back aboard the pod. Miles refastened his seat straps automatically, his mind running on overdrive, trying to construct an explanation for their bizarre welcome to Cetaganda.

"This section of the station must have been deliberately cleared of personnel," he decided aloud. "I'll bet you Betan dollars Cetagandan security is in the process of conducting a sweepsearch for that fellow. A fugitive, by God." Thief, murderer, spy? The possibilities enticed.

"He was disguised, anyway," said Ivan.

"How do you know?"

Ivan picked a few fine white strands from his green sleeve. "This isn't real hair."

"Really?" said Miles, charmed. He examined the clump of threads Ivan extended across the aisle to him. One end was sticky with adhesive. "Huh."

The pod pilot finished taking up his newly assigned coordinates; the pod now floated in space a few hundred meters from the row of docking pockets. There were no other pods locked onto the station for a dozen pockets in either direction. "I'll report this incident to the station authorities, shall I, my lords?" The sergeant reached for his comm controls.

"Wait," said Miles.

"My lord?" The pod pilot regarded him dubiously, over his shoulder. "I think we should—"

"Wait till they ask us. After all, we're not in the business of cleaning up Cetagandan security's lapses after them, are we? It's their problem."

A small grin, immediately suppressed, told Miles the pilot was amenable to this argument. "Yes, sir," he said, making it an order-received, and therefore Miles's lordly officer's responsibility, and not that of a lowly tech-sergeant. "Whatever you say, sir."

"Miles," muttered Ivan, "what do you think you're doing?"

"Observing," said Miles primly. "I'm going to observe and see how good Cetagandan station security is at their job. I think Illyan would want to know, don't you? Oh, they'll be around to question us, and take these goodies back, but this way I can get more information in return. Relax, Ivan."

Ivan settled back, his disturbed air gradually dissipating as the minutes ticked on with no further interruptions to the boredom in the little pod. Miles examined his prizes. The nerve disruptor was of some exceptionally fine Cetagandan civilian make, not military issue, in itself odd; the Cetagandans did not encourage the dispersal of deadly anti-personnel weapons among their general populace. But it did not bear the fancy decorations that would mark it as some ghem-lord's toy. It was plain and functional, of a size meant to be concealed.

The short rod was odder still. Embedded in its transparent casing was a violent glitter, looking decorative; Miles was sure microscopic examination would reveal fine dense circuitry. One end of the device was plain, the other covered with a seal which was itself locked in place.

"This looks like it's meant to be in-

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serted in something," he said to Ivan, turning the rod in the light.

"Maybe it's a dildo," Ivan smirked.

Miles snorted. "With the ghemlords, who can say? But no, I don't think so." The indented seal on the end-cap was in the shape of some clawed and dangerous-looking bird. Deep within the incised figure gleamed metallic lines, the circuit-connections. Somewhere somebody owned the mate, a raised screaming bird-pattern full of complex encodes which would release the cover, revealing . . . what? Another pattern of encodes? A key for a key. . . . It was all extraordinarily elegant. Miles smiled in sheer fascination.

Ivan regarded him uneasily. "You are going to give it back, aren't you?"

"Of course. If they ask for it."

"And if they don't?"

"Keep it for a souvenir, I suppose. It's too pretty to throw away. Maybe I'll take it home as a present to Illyan, let his cipher-laboratory elves play with it as an exercise. For about a year. It's not an amateur's bauble, even I can tell that."

Before Ivan could come up with more objections, Miles undid his green tunic and slipped the device into his own inner breast pocket. Out of sight, out of mind. "Ah—you want to keep this?" He handed the nerve disruptor across to his cousin.

Ivan plainly did. Placated by this division of the spoils, Ivan, a partner in crime now, made the little weapon disappear into his own tunic. The weapon's secret and sinister presence would do nicely, Miles calculated, to keep Ivan distracted and polite all through the upcoming disembarkation.

At last the station traffic control directed them to dock again. They locked onto a pod pocket two up from the one they had been assigned before. This time the door opened without incident. After a slight hesitation, Ivan exited through the flex tube. Miles followed him.

Six men awaited them in a gray chamber almost identical to the first one, if cleaner and better-lit. Miles recognized the Barrayaran ambassador immediately. Lord Vorob'yev was a stout solid man of about sixty-standard, sharp-eyed, smiling and contained. He wore a Vorob'yev House uniform, rather formal for the occasion Miles thought, wine-red with black trim. He was flanked by four guards in Barrayaran undress greens. Two Cetagandan station officials, in mauve and gray garb of similar style but more complex cut than the intruder's, stood slightly apart from the Barrayarans.

Only two stationers? Where were the civil police, Cetagandan military intelligence, or at least some ghem-faction's private agents? Where were the questions, and the questioners, Miles had been anticipating dissecting?

Instead he found himself greeting Ambassador Vorob'yev as if nothing had happened, just as he'd first rehearsed.

Vorob'yev was a man of Miles's father's generation, and in fact had been his appointee, back when Count Vorkosigan had still been Regent. Vorob'yev had been holding down this

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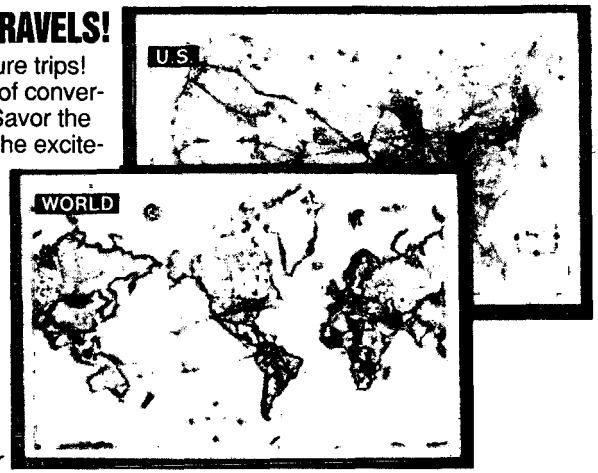

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critical post for six years, having retired from his military career to take up Imperial service on the civil side. Miles resisted an urge to salute, and gave the ambassador a formal nod instead.

"Good afternoon, Lord Vorob'yev. My father sends you his personal regards, and these messages."

Miles handed across the sealed diplomatic disk, an act duly noted by a Cetagandan official on his report panel. "Six items of luggage?" the Cetagandan inquired with a nod, as the pod pilot finished stacking them on the waiting float pallet, saluted Miles, and returned to his ship.

"Yes, that's all," said Ivan. To Miles's eye, Ivan looked stuffed and shifty, intensely conscious of the contraband in his pocket, but apparently the Cetagandan official could not read his cousin's expression as well as Miles could.

The Cetagandan waved a hand, and the ambassador nodded to his guards; two of them split off to accompany the luggage on its trip through Cetagandan inspection. The Cetagandan resealed the docking port, and bore off the float-pallet.

Ivan anxiously watched it go. "Will we get it all back?"

"Eventually. After some delays, if things run true to form," said Vorob'yev easily. "Did you gentlemen have a good trip?"

"Entirely uneventful," said Miles, before Ivan could speak. "Until we got here. Is this a usual docking port for Barrayaran visitors, or were we redirected for some other reason?" He kept one eye on the remaining Cetagandan official, watching for reaction.

Vorob'yev smiled sourly. "Sending us through the service entrance is just a little game the Cetagandans play with us, to reaffirm our status. You are correct, it is a studied insult, designed to distract our minds. I stopped allowing it to distract me some years ago, and I recommend you do the same."

The Cetagandan displayed no reaction at all. Vorob'yev was treating him with no more regard than a piece of furniture, a compliment he apparently returned by acting like one. It seemed to be a ritual.

"Thank you, sir, I'll take your advice. Uh . . . were you delayed too? We were. They cleared us to dock once and then sent us back out to cool."

"The runaround today seems particularly ornate. Consider yourselves honored, my lords. Come this way, please."

Ivan gave Miles a pleading look as Vorob'yev turned away; Miles shook his head fractionally, *Wait*. . . .

Led by the expressionless Cetagandan station official and flanked by the embassy guards, the two young men accompanied Vorob'yev up several station levels. The Barrayaran embassy's own planetary shuttle was docked to a genuine passenger lock. It had a proper VIP lounge with its own grav system in the flex tube so nobody had to float. There they shed their Cetagandan escort. Once on board the ambassador seemed to relax a little. He settled Miles and Ivan in luxuriously padded seats arranged around a bolted-down comconsole ta-

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ble. At Vorob'yev's nod a guard offered them drinks of choice while they waited for their luggage and departure clearances. Following Vorob'yev's lead they accepted a Barrayaran wine of a particularly mellow vintage. Miles barely sipped, hoping to keep his head clear, while Ivan and the ambassador made small talk about their trip and mutual Vorish friends back home. Vorob'yev seemed to be personally acquainted with Ivan's mother. Miles ignored Ivan's occasional raised-brow silent invitation to join the chat, and maybe tell Lord Vorob'yev all about their little adventure with the intruder, yes?

Why hadn't the Cetagandan authorities been all over them just now, asking questions? Miles ran scenarios through his heated brain.

It was a set-up, and I've just taken the bait, and they're letting the line play out. Considering what he knew of Cetagandans, Miles placed this possibility at the head of his list.

Or maybe it's just a time lag, and they'll be here momentarily. Or... eventually. The fugitive must first be captured, and then made to disgorge his version of the encounter. This could take time, particularly if the man had been, say, stunned unconscious during arrest. If he was a fugitive. If the station authorities had indeed been sweeping the docking area for him. If.... Miles studied his crystal cup, and swallowed a mouthful of the smoky ruby liquid, and smiled affably at Ivan.

Their luggage and its guards arrived just as they finished their drinks, experienced timing on Vorob'yev's part, Miles judged. When the ambassador rose to oversee its stowage and their departure, Ivan leaned across the table to whisper urgently to Miles, "Aren't you going to tell him about it?"

"Not yet."

"Why not?"

"Are you in such a hurry to lose that nerve disruptor? The embassy'd take it away from you as fast as the Cetagandans, I bet."

"Screw that. What are you up to?"

"I'm . . . not sure. Yet." This was not the scenario he'd expected to unfold. He'd anticipated bandying sharp exchanges with assorted Cetagandan authorities while they made him disgorge his prizes, and trading for information, consciously or unconsciously revealed. It wasn't his fault the Cetagandans weren't doing their job.

"We've got to at least report this to the embassy's military attaché."

"Yes. But not to the attaché. Illyan told me that if I had any problems —meaning, of the sort *our* department concerns itself with—I was to go to Lord Vorreedi. He's listed as a protocol officer, but he's really an ImpSec colonel and chief of ImpSec here."

"The Cetagandans don't know?"

"Of course they know. Just like we know who's really who at the Cetagandan embassy in Vorbarr Sultana. It's a polite legal fiction. Don't worry, I'll see to it." Miles sighed inwardly. He supposed the first thing the colonel would do was cut him out of the information-flow. And he dared not explain why Vorreedi shouldn't.

Ivan sat back, temporarily silenced.

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Only temporarily, Miles was sure.

Vorob'yev joined them again, settling down and hunting for his seat straps. "And that's that, my lords. Nothing taken from your possessions, nothing added. Welcome to Eta Ceta Four. There are no official ceremonies requiring your presence today, but if you're not too tired from your journey, the Marilacan Embassy is hosting an informal reception tonight for the legation community, and all its august visitors. I recommend it to your attention."

"Recommend?" said Miles. When someone with a career as long and distinguished as Vorob'yev's recommended, Miles felt, one attended.

"You'll be seeing a lot of these people over the next two weeks," Vorob'yev said. "It should provide a useful orientation."

"What should we wear?" asked Ivan. Four of the six cases they'd brought were his.

"Undress greens, please," said Vorob'yev. "Clothing is a cultural language everywhere, to be sure, but here it's practically a secret code. It is difficult enough to move among the ghem-lords without committing some defined error, and among the haut-lords it's nearly impossible. Uniforms are always correct, or, if not exactly correct, clearly not the wearer's fault, since he had no choice. I'll have my protocol office give you a list of which uniforms you are to wear at each event."

Miles felt relieved; Ivan looked faintly disappointed.

With the usual muted clinks and clanks and hisses, the flex tubes withdrew and the shuttle unlocked and undocked from the side of the station. No arresting authorities had poured through the hatch, no urgent communications had sent the ambassador hurrying forward. Miles considered his third scenario.

Our intruder got clean away. The Station authorities know nothing of our little encounter. In fact, no one knows.

Except, of course, the intruder. Miles kept his hand down, and did not touch the concealed lump in his tunic. Whatever the device was, that fellow knew Miles had it. And he could surely find out who Miles was. *I have a string on you, now. If I let it play out, something must surely climb back up it to my hand, right?* This could shape up into a nice little exercise in intelligence/counter-intelligence, better than maneuvers because it was real. No proctor with a list of answers lurked on the fringes recording all his mistakes for later analysis in excruciating detail. A practice-piece. At some stage of development an officer had to stop following orders and start generating them. And Miles wanted that promotion to ImpSec captain, oh yes. Might he somehow persuade Vorreedi to let him play with the puzzle despite his diplomatic duties?

Miles's eyes narrowed with new anticipation as they began their descent into the murky atmosphere of Eta Ceta.

CHAPTER TWO

Half-dressed, Miles wandered across the spacious bedchamber-sitting

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room the Barrayaran embassy had assigned to him, turning the glittering rod in his hand. "So if I'm meant to have this, am I meant to stash it here, or am I meant to carry it on my person?"

Ivan, neat and complete in the high-collared tunic, side-piped trousers, and half-boots of fresh undress greens, rolled his eyes ceilingward. "Will you quit fooling with that thing and get dressed, before you make us late? Maybe it's a fancy curtain-weight, and it's *meant* to drive you crazy trying to assign it some deep and sinister significance. Or drive me crazy, listening to you. Some ghem-lord's practical joke."

"A particularly subtle practical joke, if so."

"Doesn't rule it out," Ivan shrugged.

"No." Miles frowned, and limped to the comconsole desk. He opened the top drawer, and found a stylus and a pad of plastic flimsies embossed with the embassy seal. He tore off a flimsy and pressed it against the bird-figure on the rod's cap lock, then traced the indentations with the stylus, a quick, accurate, and to-scale sketch. After a moment's hesitation, he left the rod in the drawer with the pad of flimsies, and closed it again.

"Not much of a hiding place," Ivan commented. "If it's a bomb, maybe you ought to hang it out the window. For the rest of our sakes, if not your own."

"It's not a bomb, dammit. And I've thought of a hundred hiding places, but none of them are scanner-proof, so there's no point. This should be in a lead-lined blackbox, which I don't happen to have."

"I bet they have one downstairs," Ivan said. "Weren't you going to confess?"

"Yes, but unfortunately Lord Vorreedi is out of the city. Don't look at me like that, I had nothing to do with it. Vorob'yev told me the haut-lord in charge of one of the Eta Cetan Jump-point stations has impounded a Barrayaran-registered merchant ship, and its captain. For importation infractions."

"Smuggling?" said Ivan, growing interested.

"No, some complicated cockeyed Cetagandan regulations. With fees. And taxes. And fines. And a level of acrimony that's going asymptotic. Since normalizing trade relations is a current goal of our government, and since Vorreedi is apparently good at sorting out haut-lords and ghem-lords, Vorob'yev detailed him to take care of it while he's stuck here with the ceremonial duties. Vorreedi will be back tomorrow. Or the next day. Meanwhile, it won't hurt to see how far I can get on my own. If nothing interesting turns up, I'll bounce it over to the ImpSec office here anyway."

Ivan's eyes narrowed, as he processed this. "Yeah? So what if something interesting does turn up?"

"Well, then too, of course."

"So did you tell Vorob'yev?"

"Not exactly. No. Look, Illyan said Vorreedi, so Vorreedi it is. I'll take care of it as soon as the man gets back."

"In any case, it's *time*," Ivan reiterated.

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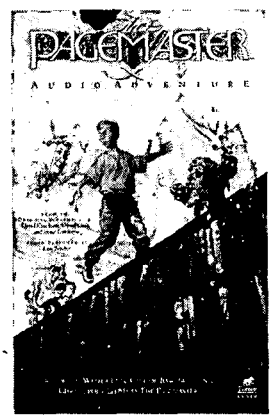

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"Yeah, yeah. . . ." Miles shuffled over to his bed, sat, and frowned at his leg braces, laid out waiting. "I have to take the time to get my leg bones replaced. I've given up on the organics, it's time to go with plastic. Maybe I could persuade them to add a few centimeters of length while they're at it. If only I'd known I had all this dead time coming up, I could have scheduled surgery and been recovering while we traveled and stood around being decorative."

"Inconsiderate of the dowager empress, not to send you a note and warn you she was dropping dead," Ivan agreed. "Wear the damn things, or Aunt Cordelia will hold me responsible if you trip over the embassy cat and break your legs. Again."

Miles growled, not very loudly. Ivan could read him entirely too well, too. He closed the cool steel protection around his lumpy, discolored, too-many-times smashed legs. At least the uniform trousers concealed his weakness. He fastened his tunic, sealed the polished short-boots, checked his hair in the mirror over his dresser, and followed the impatient Ivan, already at the door. In passing he slipped the folded flimsy into his trouser pocket, and paused in the corridor to re-key the door lock to his own palm. A somewhat futile gesture; as a trained ImpSec agent Lieutenant Vorkosigan knew exactly how insecure palm locks could be.

Despite, or perhaps because of, Ivan's prodding, they arrived in the foyer at almost the same moment as Ambassador Vorob'yev. Vorob'yev was wearing his red and black House uniform again. Not a man who liked making a lot of decisions about clothing, Miles sensed. He shepherded the two younger men into the embassy's waiting ground-car, where they sank into soft upholstery. Vorob'yev politely took the rear-facing seat across from his official guests. A driver and a guard occupied the front compartment. The car ran on the city net's computer control, but the alert driver sat ready to hit the manual override in case of some non-natural emergency. The silvered canopies closed, and they oozed out into the street.

"You may regard the Marilacan embassy as neutral but non-secured territory tonight, gentlemen," Vorob'yev advised them. "Enjoy yourselves, but not *too* much."

"Will there be many Cetagandans present," Miles asked, "or is this party strictly for us off-worlders?"

"No haut-lords, of course," said Vorob'yev. "They're all at one of the late empress's more private obsequies tonight, along with some of the highest ranking ghem-clan heads. The lower-ranking ghem-lords are at loose ends, and may be out in force, as the month of official mourning has reduced their usual social opportunities. The Marilacans have been accepting a great deal of Cetagandan 'aid' in the past few years, a greediness I predict they will come to regret. They think Cetaganda won't attack an ally."

The ground-car climbed a ramp, and swung around a corner offering a brief vista down a glittering canyon of high buildings, strung together with tubeways and transparent walks glowing in the dusk. The city seemed

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to go on forever, and this wasn't even the main center.

"The Marilacans aren't paying sufficient attention to their own wormhole nexus maps," Vorob'yev went on. "They imagine they are at a natural border. But if Marilac were directly held by Cetaganda, the next jump would bring them to Zoave Twilight, with all its cross-routes, and a whole new region for Cetagandan expansion. Marilac is in exactly the same relationship to the Zoave Twilight crossings as Vervain is to the Hegen Hub, and we all know what happened *there*." Vorob'yev's lips twisted in irony. "But Marilac has no interested neighbor to mount a rescue as your father did for Vervain, Lord Vorkosigan. And provocative incidents can be manufactured so easily."

The alert rush in Miles's chest faded. There was no personal, secret meaning in Vorob'yev's remarks. Everyone knew of Admiral Count Aral Vorkosigan's political and military role in creating the swift alliance and counter-attack that had driven off the attempted Cetagandan capture of its neighbor Vervain's wormhole jumps to the Hegen Hub. No one knew of the role ImpSec agent Miles Vorkosigan had played in bringing the admiral to the Hegen Hub in so timely a fashion. And what no one knew, no one got credit for. *Hi, I'm a hero, but I can't tell you why. It's classified.* From Vorob'yev's and practically everybody else's point of view, Lieutenant Miles Vorkosigan was a low-ranking ImpSec courier officer, a nepotistic sinecure that shuffled him off into routine duties that took him out of the way. *Mutant.*

"I thought the Hegen Alliance gave the ghem-lords a bloody enough nose at Vervain to keep them subdued for a while," said Miles. "All the expansionist party ghem-officers in deep eclipse, ghem-General Estanis committing suicide—it was suicide, wasn't it?"

"In an involuntary sort of way," said Vorob'yev. "These Cetagandan political suicides can get awfully messy, when the principal won't cooperate."

"Thirty-two stab wounds in the back, worst case of suicide they ever saw?" murmured Ivan, clearly fascinated by the gossip.

"Exactly, my lord." Vorob'yev's eyes narrowed in dry amusement. "But the ghem-commanders' loose and shifting relationship to the assorted secret haut-lord factions lends an unusual degree of deniability to their operations. The Vervain invasion is now officially described as an unauthorized misadventure. The erring officers have been corrected, thank you."

"What do they call the Cetagandan invasion of Barrayar in my grandfather's time?" Miles asked. "A reconnaissance in force?"

"When they mention it at all, yes."

"All twenty *years* of it?" asked Ivan, half-laughing.

"They tend not to go into the embarrassing details."

"Have you shared your views on Cetagandan ambitions toward Marilac with Illyan?" Miles asked.

"Yes, we keep your chief fully informed. But there are no material movements at present to support my

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theory. I'm just reasoning on principle, so far. ImpSec is watching some key indicators for us."

"I'm . . . not in that loop," said Miles. "Need-to-know and all that."

"But I trust you grasp the larger strategic picture."

"Oh, yes."

"And—upper-class gossip is not always as guarded as it should be. You two will be in position to encounter some. Plan to report it all to my chief of protocol, Colonel Vorreedi. He will be giving you daily briefings, as soon as he returns. Let him sort out which tidbits are important."

Check. Miles nodded to Ivan, who shrugged acquiescence.

"And, ah . . . try not to give away more than you gain?"

"Well, *I'm* safe," said Ivan. "I don't know anything." He smiled cheerily. Miles tried not to wince, nor mutter *We know, Ivan,* under his breath loud enough to be heard.

Since the off-planet legations were concentrated in one section of Eta Ceta's capital city, the drive was short. The ground-car descended a street level and slowed. It entered the Marilacan embassy building's garage and pulled into a brightly lit entry foyer made less subterranean with marble surfaces and decorative plants trailing from tiers of tubs. The car's canopy rose. Marilacan embassy guards bowed the Barrayaran party into the lift tubes. Doubtless they also discreetly scanned their guests—it seemed Ivan had mustered the good sense to leave that nerve disruptor in his desk drawer, too.

They exited the lift tube into a wide lobby, opening in turn onto several levels of connected public areas, already well-populated with guests, the volume of their babble invitingly high. The center of the lobby was occupied by a large multi-media sculpture, real, not a projection. Trickling water cascaded down a fountain reminiscent of a little mountain, complete with impressionistic mountain-paths one could actually walk upon. Colored flakes swirled in the air around the mini-maze, making delicate tunnels. From their green color Miles guessed they were meant to represent Earth tree leaves even before he drew close enough to make out the realistic details of their shapes. The colors slowly began to change, from twenty different greens to brilliant yellows, golds, reds and black-reds. As they swirled they almost seemed to form fleeting patterns, like human faces and bodies, to a background of tinkling like wind chimes. So was it meant to be faces and music, or was it just tricking his brain into projecting meaningful patterns onto randomness? The subtle uncertainty attracted him.

"*That's* new," commented Vorob'yev, his eye also caught. "Pretty . . . ah, good evening, Ambassador Bernaux."

"Good evening, Lord Vorob'yev." Their silver-haired Marilacan host exchanged a familiar nod with his Barrayaran counterpart. "Yes, we think it's rather fine. It's a gift from a local ghem-lord. Quite an honor. It's titled 'Autumn Leaves.' My cipher staff puzzled over the name for a half a day, and finally decided it meant 'Au-

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tumn Leaves'."

The two men laughed. Ivan smiled uncertainly, not quite following the in-joke. Vorob'yev formally introduced them to Ambassador Bernaux, who responded to their rank with elaborate courtesies, and to their age by telling them where to find the food and pointedly turning them loose. It was the Ivan-effect, Miles decided glumly. They mounted stairs toward a buffet, cut off from getting to hear whatever private comments the two older men went on to exchange. Probably just social pleasantries, but still. . . .

Miles and Ivan sampled the hor d'oeuvres, which were dainty but abundant, and selected drinks. Ivan chose a famous Marilacan wine. Miles, conscious of the flimsy in his pocket, chose black coffee. They abandoned each other with a silent wave, each to circulate after his own fashion. Miles leaned on the railing overlooking the lift-tube lobby. He sipped from the fragile cup and wondered where its stay-warm circuit was concealed—ah, there on the bottom, woven into the metallic glitter of the Marilacan embassy seal. "Autumn Leaves" was chilling down to the end of its cycle. The water in the trickling fountains froze, or appeared to, stilled to silent black ice. The swirling colors faded to the serve yellow and silver-gray of a winter sunset; the figures, if figures they were, now suggesting skeletal despair. The chime/music faded to discordant, broken whispers. It was not a winter of snow and celebration. It was a winter of death. Miles shivered involuntarily. *Damned effective.*

So, how to begin asking questions without revealing anything in return? He pictured himself buttonholing some ghem-lord, *Say, did one of your minions lose a code-key with a seal like this?* No. By far the best approach was to let his . . . adversaries, find him, but they were being tediously slow about it. Miles's eye swept the throng for men without eyebrows, without success.

But Ivan had found a beautiful woman already. Miles blinked, as he registered just how beautiful. She was tall and slim, the skin of her face and hands as delicately smooth as porcelain. Jeweled bands bound her blonde-white hair loosely at the nape of her neck, and again at her waist. The hair did not trail to its silky end until halfway to her knees. Her dress concealed rather than revealed, with layers of underslips, split sleeves, and vests sweeping to her ankles. The dark hues of the over-garments set off the pallor of her complexion, and a flash of cerulean silk underneath echoed her blue eyes. She was a Cetagandan ghem-lady, without question—she had that attenuated-elf look that suggested more than a tinge of haut-lord genes in her family tree. True, the look could be mimicked with surgeries and other therapies, but the arrogant arch to her brow had to be genuine.

Miles sensed the pheromones in her perfume while still spiraling in from three meters away. It seemed redundant; Ivan was already on overdrive, his dark eyes sparkling as he decanted some story featuring him-

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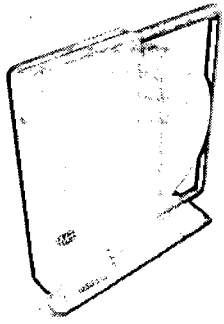

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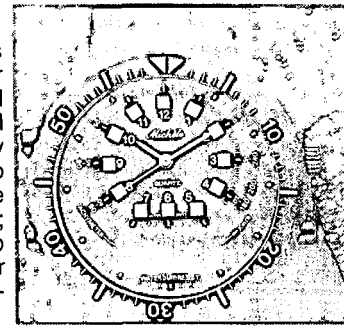

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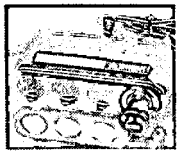

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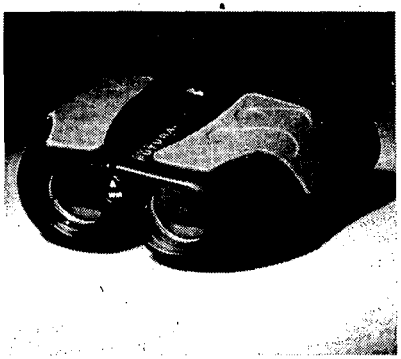

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self as hero, or at least protagonist. Something about training exercises, ah, of course, emphasizing his Barrayaran martial style. Venus and Mars, right. But she was actually smiling at something Ivan had said.

It wasn't that Miles enviously sought to deny Ivan his luck with women; it would simply be nice if some of the overflow would trickle down his way. Though Ivan claimed you had to make your own luck. Ivan's resilient ego could absorb a dozen rejections tonight for some smiling thirteenth payoff. Miles thought he would be dead of mortification by Attempt Three. Maybe he was naturally monogamous.

Hell, you had to at least achieve monogamy before you could go on to larger ambitions. So far he had failed to attach even one woman to his sawed-off person. Of course, nearly three years in covert ops, and the period before that in the all-male environs of the military academy, had limited his opportunities.

Nice theory. So why hadn't similar conditions stopped Ivan?"

Elena.... Was he still holding out for the impossible, on some level? Miles swore he wasn't nearly as choosy as Ivan—he could hardly afford to be—yet even this lovely ghem-blonde lacked . . . what? The intelligence, the reserve, the pilgrim soul? But Elena had chosen another, and probably wisely. Time and past time for Miles to move on too, and carve out some luck of his own. He just wished the project didn't feel so bleak.

Spiraling in from the other side a moment or two after Miles came a Cetagandan ghem-lord, tall and lean. The face rising up out of his dark and flowing robes was young; the fellow was not much older than Ivan and himself, Miles guessed. He was square-skulled, with prominent round cheekbones. One cheekbone was decorated with a circular patch, a decal, Miles realized—a stylized swirl of color identifying the man's rank and clan. It was a shrunken version of the full face paint a few other Cetagandans present wore, an avant-garde youth fashion currently being disapproved of by the older generation. Had he come to rescue his lady from Ivan's attentions?

"Lady Gelle," he bowed slightly, and "Lord Yenaro," she responded with a precisely graded inclination of her head, by which Miles gathered that 1) she had a higher status in the ghem-community than the man, 2) he was not her husband or brother —Ivan was probably safe.

"I see you have found some of the galactic exotics you were longing for," said Lord Yenaro to her.

She smiled back at him. The effect was downright blinding, and Miles found himself wishing she'd smile at him even though he knew better. Lord Yenaro, doubtless inoculated by a lifetime of exposure to ghem-ladies, seemed immune. "Lord Yenaro, this is Lieutenant Lord Ivan Vorpatril of Barrayar, and, ah—?" Her lashes swept down over her eyes, indicating Ivan should introduce Miles, a gesture as sharp and evocative as if she'd tapped Ivan's wrist with a fan.

"My cousin, Lieutenant Lord Miles

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Vorkosigan," Ivan supplied smoothly, on cue.

"Ah, the Barrayaran envoys!" Lord Yenaro bowed more deeply. "What luck to meet you."

Miles and Ivan both returned decent nods; Miles made sure the inclination of his head was slightly shallower than his cousin's, a fine gradation alas probably spoiled by the angle of view.

"We have a historical connection, Lord Vorkosigan," Yenaro went on. "Famous ancestors."

Miles adrenaline level shot up. *Oh, damn, this is some relative of the late ghem-General Estanis, and he's out to get the son of Aral Vorkosigan. . . .*

"You *are* the grandson of General Count Piotr Vorkosigan, are you not?"

Ah. *Ancient* history, not recent. Miles relaxed slightly. "Indeed."

"I am in a sense your opposite number, then. My grandfather was ghem-General Yenaro."

"Oh, the unfortunate commander of the, uh, what do you folks call it? The Barrayaran Expedition? The Barrayaran Reconnaissance?" Ivan put in.

"The ghem-general who lost the Barrayaran War," Yenaro said bluntly.

"Really, Yenaro, must you bring him up?" said Lady Gelle. Did she actually want to hear the end of Ivan's story? Miles could have told her a much funnier one, about the time on training maneuvers when Ivan had led his patrol into gluey waist-deep mud, and they'd all had to be winched out by hover-car. . . .

"I am not a proponent of the hero-theory of disaster," Miles said diplomatically. "General Yenaro had the misfortune to be the last of five successive ghem-generals who lost the Barrayaran War, and thus the sole inheritor of an, as it were, tontine of blame."

"Oh, well put," murmured Ivan. Yenaro, too, smiled.

"Do I understand that thing in the lobby is yours, Yenaro?" the girl inquired, clearly hoping to steer the conversation away from a fast downslide into military history. "A trifle banal for your crowd, isn't it? My mother liked it."

"It is but a practice piece," a slightly ironic bow acknowledged this mixed review. "The Marilacans were delighted with it. True courtesy considers the tastes of the recipient. It has some levels of subtlety only apparent when you walk through it."

"I thought you were specializing in the incense contests."

"I'm branching out into other media. Though I still maintain scent is a subtler sense than sight. You must let me mix for you sometime. That civet-jasmine blend you're wearing tonight absolutely clashes with the third-level formal style of your dress, you know."

Her smile went thin. "Does it."

Miles's imagination supplied background music, a scrape of rapiers, and a *Take that, varlet!* He tamped down a grin.

"Beautiful dress," Ivan put in earnestly. "You smell great."

"Mm, yes, speaking of your craving for the exotic," Lord Yenaro said to Lady Gelle, "did you know that Lord Vorpatril here is a biological birth?"

The girl's feather-faint brows drew

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in, making a tiny crease in her flawless forehead. "All births are biological, Yenaro."

"Ah, but no. The original sort of biology. From his mother's body."

"Eeeuu." Her nose wrinkled in horror. "*Really*, Yenaro. You are so obnoxious tonight. Mother is right, you and your *retro-avant* crowd are going to go too far one of these days. You are in danger of becoming someone not to know, instead of someone famous." Her distaste was directed at Yenaro, but she shifted farther from Ivan, Miles noticed.

"When fame eludes, notoriety may serve," said Yenaro, shrugging.

I was a replicator birth, Miles thought of putting in brightly, but didn't. *Just goes to show, you can never tell. Except for the brain damage, Ivan had better luck than I. . . .*

"Good *evening*, Lord Yenaro." She tossed her head and moved off. Ivan looked dismayed.

"Pretty girl, but her mind is so unformed," murmured Yenaro, as if to explain why they were better off without her company. But he looked uncomfortable.

"So, uh . . . you chose an artistic career over a military one, did you, Lord Yenaro?" Miles tried to fill the breach.

"Career?" Lord Yenaro's mouth quirked. "No, I am an amateur, of course. Commercial considerations are the death of true taste. But I hope to achieve some small stature, in my own way."

Miles trusted that last wasn't a double entendre of some sort. They followed Lord Yenaro's gaze over the rail and down into the lobby, at his fountain-thing gurgling there. "You absolutely should come see it from the inside, you know. The view is entirely altered."

Yenaro was really a rather awkward man, Miles decided, his prickly exterior barely shielding a quiveringly vulnerable *artiste's* ego. "Sure," he found himself saying. Yenaro needed no further encouragement, and, smiling anxiously, led them toward the stairs, beginning to explain some thematic theory the sculpture was supposed to be displaying. Miles sighted Ambassador Vorob'yev, beckoning to him from the far side of the balcony. "Excuse me, Lord Yenaro. Ivan, you go on, I'll catch up with you."

"Oh. . . ." Yenaro looked momentarily crushed. Ivan watched Miles escape with a light of ire in his eye that promised later retribution.

Vorob'yev was standing with a woman, her hand familiarly upon his arm. She was about forty-standard, Miles guessed, with naturally attractive features free of artificial sculptural enhancement. Her long dress and robes were styled after the Cetagandan fashion, though much simpler in detail than Lady Gelle's. She was no Cetagandan, but the dark red and cream colors and green accents of her garments worked as cleverly with her olive skin and dark curls.

"There you are, Lord Vorkosigan," said Vorob'yev. "I've promised to introduce you. This is Mia Maz, who works for our good friends at the Vervani Embassy, and who has helped us out from time to time. I recommend her to you."

Miles snapped to attention at the

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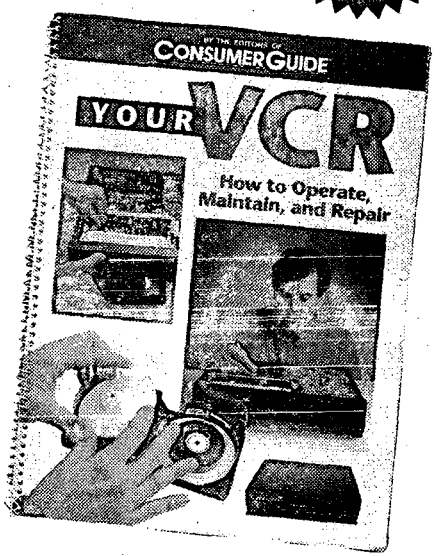

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key phrase, smiled, and bowed to the Vervani woman. "Pleased to meet you. And what do you do at the Vervani Embassy, ma'am?"

"I'm assistant chief of protocol. I specialize in women's etiquette."

"That's a separate specialty?"

"It is here, or should be. I've been telling Ambassador Vorob'yev for years that he ought to add a woman to his staff for that purpose."

"But we haven't any with the necessary experience," sighed Vorob'yev, "and you won't let me hire you away. Though I have tried."

"So start one without experience, and let her gain it," Miles suggested. "Would milady Maz consider taking on an apprentice?"

"Now there's an idea." Vorob'yev looked much struck. Maz's brows rose approvingly. "Maz, we should discuss this, but I must speak to Wilstar, whom I see just hitting the buffet over there. If I'm lucky, I can catch him with his mouth full. Excuse me." His mission of introduction accomplished, Vorob'yev faded—how else? —diplomatically away.

Maz turned her whole attention gratefully upon Miles. "Anyway, Lord Vorkosigan, I wanted to let you know that if there's anything we at the Vervani Embassy can do for the son or the nephew of Admiral Aral Vorkosigan during your visit to Eta Ceta, well . . . all that we have is at your disposal."

Miles smiled. "Don't make that offer to Ivan; he might take you up on it personally."

The woman followed his glance down over the railing, to where his tall cousin was now being guided through the sculpture by Lord Yenaro. She grinned impishly, making a dimple wink in her cheek. "Not a problem."

"So, are, uh . . . ghem-ladies really so different from ghem-lords as to make a full-time study? I admit, most Barrayarans's views of the ghem-lords have been through range-finders."

"Two years ago, I would have scorned that militaristic view. Since the Cetagandan invasion attempt we've come to appreciate it. Actually, the ghem-lords are so much like the Vor, I'd think you'd find them more comprehensible than we Vervani do. The haut-lords are . . . something else. And the haut-ladies are even more something else, I've begun to realize."

"The haut-lords' women are so thoroughly sequestered. Do they ever do anything? I mean, nobody ever sees them, do they? They have no power."

"They have their own sort of power. Their own areas of control. Parallel, not competing with their men. It all makes sense, they just never bother explaining it to outsiders."

"To inferiors."

"That, too." Her dimple flashed again.

"So . . . are you well-up on ghem- and haut-lord seals, crests, marks, that sort of thing? I can recognize about fifty clan-marks by sight, and all the military insignia and corps crests, of course, but I know that just scratches the surface."

"I'm fairly well-up. They have lay-

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ers within layers. I can't claim to know them all by any means."

Miles frowned thoughtfully, then decided to seize the moment. There was nothing else going on here tonight, that was certain. He drew the flimsy from his pocket and flattened it out against the railing. "Do you know this icon? I ran across it . . . well, in an odd place. But it smelled ghemish, or hautish, if you know what I mean."

She gazed with interest at the screaming-bird outline. "I don't recognize it right off. But you're correct, it's definitely in the Cetagandan style. It's old, though."

"How can you tell?"

"Well, it's clearly a personal seal, not a clan-mark, but it doesn't have an outline around it. For the last three generations people have been putting their personal marks in cartouches, with more and more elaborate borders. You can practically tell the decade by the border design."

"Huh."

"If you like, I can try to look it up in my resource materials."

"Would you? I'd like that very much." He folded the flimsy back up and handed it to her. "Uh, I'd appreciate it if you wouldn't show it to anyone else, though."

"Oh?" She let the syllable hang there, *Oh . . . ?*

"Excuse me. Professional paranoia. I, uh . . ." he was getting in deeper and deeper. "It's a habit."

He was rescued from tripping further over his tongue by the return of Ivan. Ivan's practiced eye summed up the attractions of the Vervani woman instantly, and he smiled attentively at her, as sincerely delighted as he had been with the last girl, and would be with the next. And the next. The ghem-lord artiste was still glued to his elbow; Miles perforce introduced them both. Maz seemed not to have met Lord Yenaro before. In front of the Cetagandan, Maz did not repeat to Ivan her message of boundless Vervani gratitude to the Vorkosigan clan, but she was definitely friendly.

"You really ought to let Lord Yenaro take you on the tour of his sculpture, Miles," Ivan said ruthlessly. "It's quite a thing. An opportunity not to be missed and all that."

I found her first, dammit. "Yes, it's very fine."

"Would you be interested, Lord Vorkosigan?" Yenaro looked earnest and hopeful.

Ivan bent to Miles's ear to whisper, "It was Lord Yenaro's gift to the Marilacan embassy. Don't be a lout, Miles, you know how sensitive the Cetagandans are about their artsy, uh, things."

Miles sighed, and mustered an interested smile for Yenaro. "Certainly. Now?"

Miles excused himself with unfeigned regrets to Maz the Vervani. The ghem-lordling led him down the stairs to the lobby, and had him pause at the entrance of the walk-through sculpture to wait for the show-cycle to begin anew.

"I'm not really qualified to judge aesthetics," Miles mentioned, hoping to head off any conversation in that direction.

"So very few are," smiled Yenaro, "but that doesn't stop them."

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"It does seem to me to be a very considerable technical achievement. Do you drive the motion with antigrav, then?"

"No, there's no antigrav in it at all. The generators would be bulky and wasteful of power. The same force drives the leaves' motion as drives their color changes—or so my technicians explained it to me."

"Technicians? I somehow pictured you putting all this together with your own hands."

Yenaro spread his hands—pale, long-fingered, and thin—and stared at them as if surprised to find them on the ends of his wrists. "Of course not. Hands are to be hired. Design is the test of the intellect."

"I must disagree. In my experience, hands are integral with brains, almost another lobe for intelligence. What one does not know through one's hands, one does not truly know."

"You are a man capable of true conversation, I perceive. You must meet my friends, if your schedule here permits. I'm hosting a reception at my home in two evenings' time—do you suppose—?"

"Um, maybe." That evening was a blank as far as the funeral formalities went. It could be quite interesting, a chance to observe how the ghem-lordlings of his own generation operated without the inhibitions of their elders; a glimpse into the future of Cetaganda. "Yes, why not?"

"I'll send you directions. Oh." Yenaro nodded toward the fountain, which was starting up with its high-canopied summer greens again. "Now we can go in."

Miles did not find the view from inside the fountain-maze all that much different from the outside. In fact, it seemed less interesting, as at close range the illusion of forms in the flitting leaves was reduced. The music was clearer, though. It rose to a crescendo, as the colors began to change. "Now you'll see something," said Yenaro, with evident satisfaction.

It was all sufficiently distracting, it took another moment for Miles to realize that he was *feeling* something—tingling and heat, coming from his leg braces lying against his skin. He schooled himself not to react, till the heat began to rise.

Yenaro was babbling on with artistic enthusiasm, pointing out effects, *Now, watch this*— Brilliant colors swirled before Miles's eyes. A distinct sensation of scalding flesh crept up his legs.

Miles muffled his scream to a less-edged yell, and managed not to jump for the water. God knew, he might be electrocuted. The few seconds it took him to pelt out of the maze brought the steel of his braces to a temperature sufficient to boil water. He gave up dignity, dove for the floor, and yanked up his trouser legs. His first snatch at the clamps burned his hands, too. He swore, eyes watering, and tried again. He tore off his boots, snapped loose the braces, and flung them aside with a clatter, and curled up momentarily in overwhelming pain. The braces had left a pattern of rising white welts surrounded by an angry red border of flesh on shin, knees, and ankles.

Yenaro was flapping about in dis-

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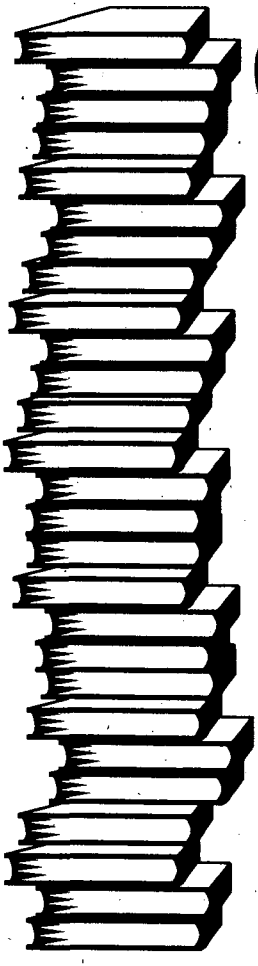

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tress, calling loudly for help. Miles looked up to find himself the center of an audience of about fifty or so shocked and bewildered people, witnessing his display. He stopped writhing and swearing, and sat panting, his breath hissing through clenched teeth.

Ivan and Vorob'yev shouldered through the mob from different directions. "Lord Vorkosigan! What has happened?" asked Vorob'yev urgently.

"I'm all right," said Miles. He was not all right, but this was not the time or place to go into the details. He pulled his trouser legs quickly back down, concealing the burns.

Yenaro was yammering on in dismay, "What happened? I had no idea—are you all right, Lord Vorkosigan? Oh *dear*."

Ivan bent and prodded at a cooling brace. "Yes, what the hell . . . ?"

Miles considered the sequence of sensations, and their possible causes. Not antigrav, not noticeable to anyone else, and it had slid right past Marilacan embassy security. Hidden in plain sight? Right. "I think it was some sort of electromagnetic hysteresis effect. The color-changes in the display are apparently driven by a reversing magnetic field at low level. No problem for most people. For me, well, it wasn't quite as bad as shoving my leg braces into a microwave, but—you get the idea." Grinning, he got to his feet. Ivan, looking very worried, had already collected his flung boots and the offending braces. Miles let him keep them. He didn't want to touch them just now. He blundered rather blindly closer to Ivan, and muttered under his breath, "Get me out of here. . . ." He was shivering and shocky, as Ivan's hand on his shoulder could sense. Ivan gave him a short, understanding nod, and swiftly withdrew through the crowd of finely-dressed men and women, some of whom were already turning away.

Ambassador Bernaux hurried up, and added his worried apologies to Yenaro's one-man chorus. "Do you wish to stop in to the embassy infirmary, Lord Vorkosigan?" Bernaux offered.

"No. Thank you. I'll wait till we get home, thanks." *Soon, please.*

Bernaux bit his lip, and regarded the still-apologizing Lord Yenaro. "Lord Yenaro, I'm afraid—"

"Yes, yes, turn it off at *once*," said Yenaro. "I will send my servants to remove it immediately. I had no idea—everyone else seemed to be enjoying—it must be redesigned. Or destroyed, yes, destroyed at once. I am so sorry—this is so embarrassing—"

Yes, isn't it? thought Miles. A show of his physical weakness, displayed to a maximum audience at the earliest possible moment.

"No, no, don't destroy it," said Ambassador Bernaux, horrified. "But we certainly must have it examined by a safety engineer, and modified, or perhaps a warning posted."

Ivan reappeared at the edge of the dispersing crowd, and gave Miles a thumbs-up signal. After a few more minutes of excruciating social niceties, Vorob'yev and Ivan managed to get him escorted back down the lift tube to the waiting Barrayaran em-

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bassy ground-car. Miles flung himself into the upholstery and sat, grinning in pain, breath shallow. Ivan eyed his shivering form, skinned out of his tunic, and tucked it around Miles's shoulders. Miles let him.

"All right, let's see the damages," demanded Ivan. He propped one of Miles's heels on his knee and rolled back the trouser leg. "Damn, that's got to hurt."

"Quite," agreed Miles thinly.

"It could hardly have been an assassination attempt, though," said Vorob'yev, his lips compressed with calculation.

"No," agreed Miles.

"Bernaux told me he had his own security people examine the sculpture before they installed it. Looking for bombs and bugs, of course, but they cleared it."

"I'm sure they did. This could not have hurt anyone . . . but me."

Vorob'yev followed his reasoning without effort. "A trap?"

"Awfully elaborate, if so," noted Ivan.

"I'm . . . not sure," said Miles. *I'm meant to be not sure. That's the beauty of it.* "It had to have taken days, maybe weeks, of preparation. We didn't even know we were coming here till two weeks ago. When did it arrive at the Marilacan embassy?"

"Last night, according to Bernaux," Vorob'yev said.

"Before we even arrived." *Before our little encounter with the man with no eyebrows. It can't possibly be connected—can it?* "How long have we been scheduled for that party?"

"The embassies arranged the invitations about three days ago," said Vorob'yev.

"The timing is awfully tight, for a conspiracy," Ivan observed.

Vorob'yev thought it over. "I think I must agree with you, Lord Vorpatril. Shall we put it down as an unfortunate accident, then?"

"Provisionally," said Miles. *That was no accident. I was set up. Me, personally. You know there's a war on when the opening salvo arrives.*

Except that, usually one knew *why* a war had been declared. It was all very well to swear not to be blindsided again, but who was the enemy here?

Lord Yenaro, I bet you throw a fascinating party. I wouldn't miss it for worlds.

CHAPTER THREE

"The proper name for the Cetagandan imperial residence is the Celestial Garden," said Vorob'yev, "but all the galactics just call it Xanadu. You'll see why in a moment. Duvi, take the scenic approach."

"Yes, my lord," returned the young sergeant who was driving. He altered the control program. The Barrayaran embassy air-car banked, and shot through a shining stalagmite array of city towers.

"*Gently*, if you please, Duvi. My stomach, at this hour of the morning. . . ."

"Yes, my lord," Regretfully, the driver slowed them to a saner pace. They dipped, wove around a building that Miles estimated must have been a kilometer high, and rose again. The

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horizon dropped away.

"Woah," said Ivan. "That's the biggest force dome I've ever seen. I didn't know they could expand them to that size."

"It absorbs the output of an entire generating plant," said Vorob'yev, "for the dome alone. Another for the interior."

A flattened opalescent bubble six kilometers across reflected the late morning sun of Eta Ceta. It lay in the midst of the city like a vast egg in a bowl, a pearl beyond price. It was ringed first by a kilometer-wide park with trees, then by a street reflecting silver, then by another park, then by an ordinary street, thick with traffic. From this eight wide boulevards fanned out like the spokes of a wheel, centering the city. Centering the universe, Miles gained the impression. The effect was doubtless intended.

"The ceremony today is in some measure a dress rehearsal for the final one in a week and a half," Vorob'yev went on, "since absolutely everyone will be there, ghem-lords, haut-lords, galactics and all. There will likely be organizational delays. As long as they're not on our part. I spent a week of hard negotiating to get you your official rankings and place in this."

"Which is?" said Miles.

"You two will be placed equivalently to second-order ghem-lords." Vorob'yev shrugged. "It was the best I could do."

In the mob, though toward the front of it. The better to watch without being much noticed himself, Miles supposed. Today, that seemed like a good idea. All three of them, Vorob'yev, Ivan, and himself, were wearing their respective House mourning uniforms, logos and decorations of rank stitched in black silk on black cloth. Maximum formal, since they were to be in the imperial presence itself. Miles ordinarily liked his Vorkosigan House uniform, whether the original brown and silver or this somber and elegant version, because the tall boots not only allowed but required him to dispense with the leg braces. But getting the boots on over his swollen burns this morning had been . . . painful. He was going to be limping more noticeably than usual, even tanked as he was on pain-killers. *I'll remember this, Yenaro.*

They spiraled down to a landing by the most southerly dome entrance, fronted by a landing lot already crowded with other vehicles. Vorob'yev dismissed the driver and air-car.

"We keep no escort, my lord?" Miles said doubtfully, watching it go, and awkwardly shifting the long polished maplewood box he carried.

Vorob'yev shook his head. "Not for security purposes. No one but the Cetagandan emperor himself could arrange an assassination inside the Celestial Garden, and if he wished to have you eliminated here, a regiment of bodyguards would do you no good."

Some very tall men in the dress uniforms of the Cetagandan Imperial Guard vetted them through the dome locks. The guardsmen shunted them toward a collection of float-pallets set up as open cars, with white silky upholstered seats, the color of Cetagan-

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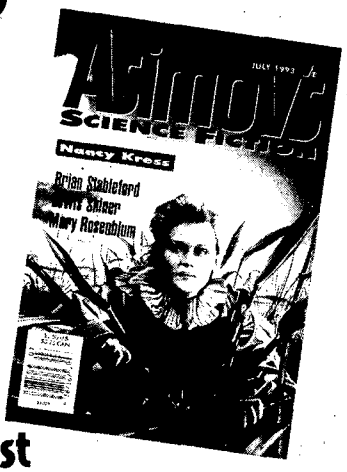

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dan imperial mourning. Each ambassadorial party was bowed on board by what looked to be senior servants in white and gray. The robotically-routed float-cars set off at a sedate pace a hand-span above the white-jade-paved walkways winding through a vast arboretum and botanical garden. Here and there Miles saw the rooftops of scattered and hidden pavilions peeking through the trees. All the buildings were low and private, except for some elaborate towers poking up in the center of the magic circle, almost three kilometers away. Though the sun shone outside on an Eta Ceta spring day, the weather inside the dome was set to a gray, cloudy, and appropriately mournful dampness, promising, but doubtless not delivering, rain.

At length they wafted to a sprawling pavilion just to the west of the central towers, where another servant bowed them out of the car and directed them inside, along with a dozen other delegations. Miles stared around, trying to identify them all.

The Marilacans, yes, there was the silver-haired Bernaux, some green-clad people who might be Jacksonians, a delegation from Aslund which included their chief of state—even they had only two guards, disarmed—the Betan ambassadoress in a black-on-purple brocade jacket and matching sarong, all streaming in to honor this one dead woman who would never have met them face to face when alive. *Surreal* seemed an understatement. Miles felt like he'd crossed the border into Faerie, and when they emerged this afternoon, a hundred years would have passed outside. The galactics had to pause at the doorway to make way for the party of a haut-lord satrap governor. *He* had an escort of a dozen ghem-guards, Miles noted, in full formal face paint, orange, green, and white swirls.

The decor inside was surprisingly simple—tasteful, Miles supposed—tending heavily to the organic, arrangements of live flowers and plants and little fountains, as if bringing the garden indoors. The connecting halls were hushed, not echoing, yet one's voice carried clearly. They'd done something extraordinary with acoustics. More palace servants circulated offering food and drinks to the guests.

A pair of pearl-colored spheres drifted at a walking pace across the far end of one hall, and Miles blinked at his first glimpse of haut-ladies. Sort of.

Outside of their very private quarters haut-women all hid themselves behind personal force-shields, usually generated, Miles had been told, from a float-chair. The shields could be made any color, according to the mood or whim of the wearer, but today would all be white for the occasion. The haut-lady could see out with perfect clarity, but no one could see in. Or reach in, or penetrate the barrier with stunner, plasma, or nerve disruptor fire, or small projectile weapons or minor explosions. True, the force-screen also eliminated the opportunity to fire out, but that seemed not to be a haut-lady concern. The shield could be cut in half with a gravitic imploder lance, Miles sup-

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posed, but the imploders' bulky power packs, massing several hundred kilos, made them strictly field ordnance, not hand weapons.

Inside their bubbles, the haut-women could be wearing anything. Did they ever cheat? Slop around in old clothes and comfy slippers when they were supposed to be dressed up? Go nude to garden parties? Who could tell?

A tall elderly man in the pure white robes reserved for the haut- and ghem-lords approached the Barrayaran party. His features were austere, his skin finely wrinkled and almost transparent. He was the Cetagandan equivalent of an imperial major-domo, apparently, though with a much more flowery title, for after collecting their credentials from Vorob'yev he provided them with exact instructions as to their place and timing in the upcoming procession. His attitude conveyed that outlanders might be hopelessly gauche, but if one repeated the directions in a firm tone and made them simple enough, there was a chance of getting through this ceremony without disgrace.

He looked down his hawk-beak nose at the polished box. "And this is your gift, Lord Vorkosigan?"

Miles managed to unlatch the box and open it for display without dropping it. Within, nestled on a black velvet bed, lay an old, nicked sword. "This is the gift selected from his collection by my emperor, Gregor Vorbarra, in honor of your late empress. It is the sword his imperial ancestor Dorca Vorbarra the Just carried in the First Cetagandan War." One of several, but no need to go into that. "A priceless and irreplaceable historical artifact. Here is its documentation of provenance."

"Oh," the major-domo's feathery white brows lifted almost despite themselves. He took the packet, sealed with Gregor's personal mark, with more respect. "Please convey my imperial master's thanks to yours." He half-bowed, and withdrew.

"*That* worked well," said Vorob'yev with satisfaction.

"I should bloody think so," growled Miles. "Breaks my heart." He handed off the box to Ivan to juggle for a while.

Nothing seemed to be happening just yet—organizational delays, Miles supposed. He drifted away from Ivan and Vorob'yev in search of a hot drink. He was on the point of capturing something steaming and, he hoped, non-sedating, from a passing tray when a quiet voice at his elbow intoned, "Lord Vorkosigan?"

He turned, and stifled an indrawn breath. A short and rather androgynous elderly—woman?—stood by his side, dressed in the gray and white of Xanadu's service staff. Her head was bald as an egg, her face devoid of hair. Not even eyebrows. "Yes . . . ma'am?"

"Ba," she said in the tone of one offering a polite correction. "A lady wishes to speak with you. Would you accompany me, please?"

"Uh . . . sure." She turned and paced soundlessly away, and he followed in alert anticipation. A lady? With luck, it might be Mia Maz of the

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Vervani delegation, who ought to be around somewhere in this mob of a thousand people. He was developing some urgent questions for her. *No eyebrows? I was expecting a contact sometime, but . . . here?*

They exited the hall. Passing out of sight of Vorob'yev and Ivan stretched Miles's nerves still further. He followed the gliding servant down a couple of corridors, and across a little open garden thick with moss and tiny flowers misted with dew. The noises from the reception hall still carried faintly through the damp air. They entered a small building, open to the garden on two sides and floored with dark wood that made his black boots echo unevenly in time with his limping stride. In a dim recess of the pavilion, a woman-sized pearlescent sphere floated a few centimeters above the polished floor, which reflected an inverted halo from its light.

"Leave us," a voice from the sphere directed the servant, who bowed and withdrew, eyes downcast. The transmission through the force screen gave the voice a low, flat timbre.

The silence lengthened. Maybe she'd never seen a physically imperfect man before. Miles bowed, and waited, trying to look cool and suave, and not stunned and wildly curious.

"So, Lord Vorkosigan," came the voice again at last. "Here I am."

"Er . . . quite." Miles hesitated. "And just who are you, milady, besides a very pretty soap-bubble?"

There was a longer pause, then, "I am the haut Rian Degtiar. Servant of Celestial Lady, and Handmaiden of the Star Crèche."

Another flowery haut-title that gave no clue to its function. He could name every ghem-lord on the Cetagandan General Staff, all the satrap governors and their ghem-officers, but this female haut-babble was new to him. But the Celestial Lady was the polite name for the late Empress haut Lisbet Degtiar, and that name at least he knew—

"You are a relative of the late Dowager Empress, milady?"

"I am of her genomic constellation, yes. Three generations removed. I have served her half my life."

A lady-in-waiting, all right. One of the old empress's personal retinue, then, the most inward of insiders. *Very* high rank, probably very aged as well. "Uh . . . you're not related to a ghem-lord named Yenaro, by chance, are you?"

"Who?" Even through the force screen the voice conveyed utter bafflement.

"Never mind. Clearly not important." His legs were beginning to throb. Getting the damn boots back off when he returned to the embassy was going to be an even better trick than getting them on had been. "I could not help noticing your serving woman. Are there many folk around here with no hair?"

"It is not a woman. It is Ba."

"Ba?"

"The neuter ones, the Emperor's high-slaves. In his Celestial Father's time it was the fashion to make them smooth like that."

Ah. Genetically-engineered, genderless servants. He'd heard rumors about them, mostly connected, illogically enough, with sexual scenarios

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that had more to do with the teller's hopeful fantasies than any likely reality. But they were reputed to be a race utterly loyal to the lord who had, after all, literally created them. "So not all Ba are hairless, but all the hairless ones are Ba?" he worked it out.

"Yes. . . ." More silence, then, "Why have you come to the Celestial Garden, Lord Vorkosigan?"

His brow wrinkled. "To hold up Barrayar's honor in this circu—um, solemn procession, and to present your late empress's bier-gift. I'm an envoy. By appointment of Emperor Gregor Vorbarra, whom *I* serve. In my own small way."

Another, longer pause. "You mock me in my misery."

"What?"

"What do you *want*, Lord Vorkosigan?"

"What do *I* want? You called me here, Lady, isn't it the other way around?" He rubbed his neck, tried again. "Er . . . can I help you, by chance?"

"You?!"

Her astonished tone stung him. "Yeah, me! I'm not as . . ." *incompetent as I look*, "I've been known to accomplish a thing or two, in my time. But if you won't give me a clue as to what this is all about, I can't. I will if I do know but I can't if I don't. Don't you see?" Now he had confused himself, tongue-tangled. "Look, can we start this conversation over?" He bowed low. "Good day, I am Lord Miles Vorkosigan of Barrayar. How may I assist you, milady?"

"Thief—!"

The light dawned at last. "*Oh*. Oh, no. I am a Vorkosigan, and no thief, milady. Though as possibly a recipient of stolen property, I may be a fence," he allowed judiciously.

More baffled silence; perhaps she was not familiar with criminal jargon. Miles went on a little desperately, "Have you, uh, by chance lost an object? Rod-shaped electronic device with a bird-crest seal on the cap?"

"You have it!" Her voice was a wail of dismay.

"Well, not *on* me."

Her voice went low, throaty, desperate. "You still have it. You must return it to me."

"Gladly, if you can prove it belongs to you. I certainly don't pretend it belongs to me," he added pointedly.

"You would do this . . . for nothing?"

"For the honor of my name, and, er . . . I *am* ImpSec. I'd do almost anything for information. Satisfy my curiosity, and the deed is done."

Her voice came back in a shocked whisper, "You mean you don't even know what it *is?"*

The silence stretched for so long after that, he was beginning to be afraid the old lady had fainted dead away in there. Processional music wafted faintly through the air from the great pavilion.

"Oh, shi—er, oh. That damn parade is starting, and I'm supposed to be near the front. Milady, how can I reach you?"

"You can't." Her voice was suddenly breathless. "I have to go too. I'll send for you." The white bubble rose, and began to float away.

"Where? When—?" The music was

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building toward the start-cue.

"Say nothing of this!"

He managed a sketchy bow at her retreating maybe-back, and began hobbling hastily across the garden. He had a horrible feeling he was about to be very publicly late.

When he wended his way back into the reception area, he found the scene was every bit as bad as he'd feared. A line of people was advancing to the main exit, toward the tower buildings, and Vorob'yev in the Barrayaran delegation's place was dragging his feet, creating an obvious gap, and staring around urgently. He spotted Miles and mouthed silently, *Hurry up, dammit!* Miles hobbled faster, feeling as if every eye in the room was on him.

Ivan, with an exasperated look on his face, handed over the box to him as he arrived. "Where the hell were you all this time, in the lav? I looked there—"

"Sh. Tell you later. I've just had the most bizarre...." Miles struggled with the heavy maplewood box, and straightened it around into an appropriate presentational position. He marched forward across a courtyard paved with more carved jade, catching up at last with the delegation in front of them just as they reached the door to one of the high-towered buildings. They all filed into an echoing rotunda. Miles spied a few white bubbles in the line ahead, but there was no telling if one was his old hautlady. The game-plan called for everyone to slowly circle the bier, genuflect, and lay their gifts in a spiral pattern in order of seniority/status/clout, and file out the opposite doors to the northern pavilion (for the haut-lords and ghem-lords), or the eastern pavilion (for the galactic ambassadors) where a funeral luncheon would be served.

But the steady procession stopped, and began to pile up in the wide arched doorways. From the rotunda ahead, instead of quiet music and hushed, shuffling footsteps, a startled babble poured. Voices were raised in sharp astonishment, then other voices in even sharper command.

"What's gone wrong?" Ivan wondered, craning his neck. "Did somebody faint or something?"

Since Miles's eye-level view was of the shoulders of the man ahead of him, he could scarcely answer this. With a lurch, the line began to proceed again. It reached the rotunda, but then was shunted out a door immediately to the left. A ghem-commander stood at the intersection, directing traffic with low-voiced instructions, repeated over and over, "Please retain your gifts and proceed directly around the outside walkway to the Eastern Pavilion, please retain your gifts and proceed directly to the Eastern Pavilion, all will be reordered presently, please retain—"

At the center of the rotunda, above everyone's heads on a great catafalque, lay the Dowager Empress in state. Even in death outlander eyes were not invited to look upon her. Her bier was surrounded by a force-bubble, made translucent; only a shadow of her form was visible through it, as if through gauze, a white-clad, slight, sleeping ghost. A

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line of mixed ghem-guards apparently just drafted from the passing satrap governors stood in a row from catafalque to wall on either side of the bier, shielding something else from the passing eyes.

Miles couldn't stand it. *After all, they can't massacre me here in front of everybody, can they?* He jammed the maplewood box at Ivan, and ducked under the elbow of the ghem-officer trying to shoo everyone out the other door. Smiling pleasantly, his hands held open and empty, he slipped between two startled ghem-guards, who were clearly not expecting such a rude and impudent move.

On the other side of the catafalque, in the position reserved for the first gift of the haut-lord of highest status, lay a dead body. Its throat was cut, and quantities of fresh red blood pooled on the shimmering green malachite floor all around, soaking into its gray and white palace servitor's uniform. A thin jeweled knife was clutched rigorously in its out-flung right hand. *It* was exactly the term for the corpse, too. A bald, eyebrowless, man-shaped creature, elderly but not frail. Miles recognized their intruder from the personnel pod even without the false hair. His own heart seemed to stop in astonishment.

Somebody's just raised the stakes in this little game.

The highest-ranking ghem-officer in the room swooped down upon him. Even through the swirl of face paint his smile was fixed, the look of a man constrained to be polite to someone he would more naturally have preferred to bludgeon to the pavement. "Lord Vorkosigan, would you rejoin your delegation, please?"

"Of course. Who was that poor fellow?"

The ghem-commander made little herding motions at him—the Cetagandan was not fool enough to actually touch him, of course—and Miles allowed himself to be moved off. Grateful, irate, and flustered, the man was actually surprised into an unguarded reply. "It is Ba Lura, the Celestial Lady's most senior servitor. The Ba has served her for sixty years and more—it seems to have wished to follow on and serve her in death as well. A most tasteless gesture, to do it *here*." The ghem-commander buffeted Miles near enough to the again-stopped line of delegates for Ivan's long arm to reach out, grab him, and pull him in, and march him doorward with a firm fist in the middle of his back.

"What the hell is going *on?*" Ivan bent his head to hiss in Miles's ear from behind.

And where were you when the murder took place, Lord Vorkosigan? Except that it didn't look like a murder, it really did look like a suicide. Done in a most archaic manner. Less than thirty minutes ago. While he had been off talking with the mysterious white bubble, who might or might not have been haut Rian Degtiar, how the hell was he to tell? The corridor seemed to be spinning, but Miles supposed it was only his brain.

"You should not have gotten out of line, my lord," said Vorob'yev severely. "Ah . . . what was it you saw?"

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Miles's lip curled, but he tamped it back down. "One of the late Dowager Empress's oldest Ba servants has just cut its throat at the foot of her bier. I didn't know the Cetagandans made a fashion of human sacrifice. Not officially, anyway."

Vorob'yev's lips pursed in a soundless whistle, then flashed a brief, instantly-stifled grin. "How *awkward* for them," he purred. "They are going to have an interesting scramble, trying to retrieve *this* ceremony."

Yes. So if the creature was so loyal, why did it arrange what it must have known would be a major embarrassment for its masters? Posthumous revenge? Admittedly, with Cetagandans that's the safest kind....

By the time they completed an interminable hike around the outside of the central towers to the pavilion on the eastern side, Miles's legs were killing him. In a huge hall, the several hundred galactic delegates were being seated at tables by an army of servitors, all moving just a little faster than strict dignity would have preferred. Since some of the bier-gifts the other delegates carried were even bulkier than the Barrayarans's maple-wood box, the seating was going slowly and more awkwardly than planned, with a lot of people jumping up and down and rearranging themselves, to the servitors' evident dismay. Somewhere deep in the bowels of the building Miles pictured a squadron of harried Cetagandan cooks swearing many colorful and obscene Cetagandan oaths.

Miles spotted the Vervani delegation being seated about a third of the way across the room. He took advantage of the confusion to slip out of his assigned chair, weave around several tables, and try to seize a word with Mia Maz.

He stood by her elbow, and smiled tensely. "Good afternoon, m'lady Maz. I have to talk—"

"Lord Vorkosigan! I tried to talk with you—" they cut across each other's greetings.

"You first," he ducked his head at her.

"I tried to call you at your embassy earlier, but you'd already left. What in the world happened in the rotunda, do you have any idea? For the Cetagandans to alter a ceremony of this magnitude in the middle—it's unheard of."

"They didn't exactly have a choice. Well, I suppose they could have ignored the body and just carried on around it—*I* think that would have been much more impressive, personally—but evidently they decided to clean it up first." Again Miles repeated what he was beginning to think of as "the official version" of Ba Lura's suicide. He had the total attention of everyone within earshot. To hell with it, the rumors would be flying soon enough no matter what he said or didn't say.

"Did you have any luck with that little research question I posed to you last night?" Miles continued. "I, uh ... don't think this is the time or place to discuss it, but—"

"Yes, and yes," Maz said.

And not over any holovid transmission channel on this planet, ei-

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ther, Miles thought, *supposedly secured or not.* "Can you stop by the Barrayaran Embassy, directly after this? We'll . . . take tea, or something."

"I think that would be very appropriate," Maz said. She watched him with newly-intensified curiosity in her dark eyes.

"I need a lesson in etiquette," Miles added, for the benefit of their interested nearby listeners.

Maz's eyes twinkled in something that might have been suppressed amusement. "So I have heard it said, my lord," she murmured.

"By—" *whom?* He choked off. *Vorob'yev, I fear.* "'Bye," he finished instead, rapped the table cheerily and retreated back to his proper place. Vorob'yev watched Miles seat himself with a slightly dangerous look in his eyes that suggested he was thinking of putting a leash on the peripatetic young envoy soon, but he made no comment aloud.

By the time they had eaten their way through about twenty courses of tiny delicacies, which more than made up in numbers what they lacked in volume, the Cetagandans had reorganized themselves. The haut-lord major-domo was apparently one of those commanders who was never more masterly than when in retreat, for he managed to get everyone marshaled in the correct order of seniority again even though the line was now being cycled through the rotunda in reverse. One sensed the major-domo would be cutting *his* throat later, in the proper place and with the proper ceremony, and not in this dreadful harum-scarum fashion.

Miles laid down the maplewood box on the malachite floor in the second turning of the growing spiral of gifts, about a meter from where Ba Lura had poured out its life. The unmarked, perfectly polished floor wasn't even damp. And had the Cetagandan security people had time to do a forensics scan before the clean-up? Or had someone been counting on the hasty destruction of the subtler evidence? *Damn, I wish I could have been in charge of this, just now.*

The white float-cars were waiting on the other side of the eastern pavilion, to carry the emissaries back to the gates of the Celestial Garden. The entire ceremony had run only about an hour late, but Miles's sense of time was inverted from his first whimsical vision of Xanadu as Faerie. He felt as if a hundred years had gone by inside the dome, while only a morning had passed in the outside world. He winced painfully in the bright afternoon light, as Vorob'yev's sergeant-driver brought the embassy air-car to their pick-up point. Miles fell gratefully into his seat.

I think they're going to have to cut these bloody boots off, when we get back home.

CHAPTER FOUR

"Pull,"Miles said, and set his teeth.

Ivan grasped his boot by the ankle and heel, braced his knee against the end of the couch upon which Miles lay, and yanked dutifully.

"Yeow!"

Ivan stopped. "Does that hurt?"

"Yes, keep going, dammit."

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Ivan glanced around Miles's personal suite. "Maybe you ought to go downstairs to the embassy infirmary again."

"Later. I am not going to let that butcher of a physician dissect my best boots. Pull."

Ivan put his back into it, and the boot at last came free. He studied it in his hand a moment, and smiled slowly. "You know, you're not going to be able to get the other one off without me," he observed.

"So?"

"So . . . give."

"Give what?"

"Knowing your usual humor, I'd have thought you'd be as amused by the idea of an extra corpse in the funeral chamber as Vorob'yev was, but you came back looking like you'd just seen your grandfather's ghost."

"The Ba had cut its throat. It was a messy scene."

"I think you've seen messier corpses."

Oh, yes. Miles eyed his remaining booted leg, which was throbbing, and pictured himself limping through the corridors of the embassy seeking a less demanding valet. No. He sighed. "Messier, but no stranger. You'd have twitched too. We met the Ba yesterday, you and I. You wrestled with it in the personnel pod."

Ivan glanced toward the comconsole desk drawer where the mysterious rod remained concealed, and swore. "That does it. We've got to report this to Vorob'yev."

"If it *was* the same Ba," Miles put in hastily. "For all I know, the Cetagandans clone their servants in batches, and the one we saw yesterday was this one's twin or something."

Ivan hesitated. "You think so?"

"I don't know, but I know where I can find out. Just let me have one more pass at this, before we send up the flag, please? I've asked Mia Maz from the Vervani embassy to stop in and see me. If you wait . . . I'll let you sit in."

Ivan contemplated this bribe. "Boot!" Miles demanded, while he was thinking. Somewhat absently, Ivan helped pull it off.

"All right," he said at last, "but after we talk to her, we report to ImpSec."

"Ivan, I *am* ImpSec," snapped Miles. "Three years of training and field experience, remember? Do me the honor of grasping that I may just possibly know what I'm doing!" *I wish to hell I knew what I was doing.* Intuition was nothing but the subconscious processing of subliminal clues, he was fairly sure, but *I feel it in my bones* made too uncomfortably thin a public defense for his actions. *How can you know something before you know it?* "Give me a chance."

Ivan departed for his own room to change clothes without making any promises. Freed of the boots, Miles staggered to his washroom to gulp down some more painkillers, and skin out of his formal House mourning and into loose black fatigues. Judging by the embassy's protocol list, Miles's private chamber was going to be the only place he could wear the fatigues.

Ivan returned all too soon, breezily trim in undress greens, but before he could continue asking questions Miles

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couldn't answer or demanding justifications Miles couldn't offer, the comconsole chimed. It was the staffer from the embassy's lobby, downstairs.

"Mia Maz is here to see you, Lord Vorkosigan," the man reported. "She says she has an appointment."

"That's correct. Uh . . . can you bring her up here, please?" Was his suite monitored by embassy security? He wasn't about to draw attention by inquiring. But no. If ImpSec were eavesdropping, he'd certainly have had to deal with some stiff interrogation from their offices below-stairs by now, either via Vorob'yev or directly. They were extending him the courtesy of privacy, as yet, in his personal space—though probably not on his comconsole. Every public forum in the building was guaranteed to be bugged, though.

The staffer ushered Maz to Miles's door in a few moments, and Miles and Ivan hastened to get her comfortably seated. She too had stopped to change clothes, and was now wearing a form-fitting jumpsuit and knee-length vest suitable for street wear. Even at forty-odd her form supported the style very nicely. Miles got rid of the staffer by sending him off with an order for tea and, at Ivan's request, wine.

Miles settled down on the other end of the couch and smiled hopefully at the Vervani woman. Ivan was forced offsides to a nearby chair. "Milady Maz. Thank you for coming."

"Just Maz, please," she smiled in return. "We Vervani don't use such titles. I'm afraid we have trouble taking them seriously."

"You must be good at keeping a straight face, or you could not function so well here."

Her dimple winked at him. "Yes, my lord."

Ah yes, Vervain was one of those so-called democracies; not quite as insanely egalitarian as the Betans, but they had a definite cultural drift in that direction. "My mother would agree with you," Miles conceded. "She would have seen no inherent difference between the two corpses in the rotunda. Except their method of arriving there, of course. I take it this suicide was an unusual and unexpected event?"

"Unprecedented," said Maz, "and if you know Cetagandans, you know just how strong a term that is."

"So Cetagandan servants do not routinely accompany their masters in death like a pagan sacrifice."

"I suppose the Ba Lura was unusually close to the Empress; it had served her for so long," said the Vervani woman. "Since before any of us were born."

"Ivan was wondering if the haut-lords cloned their servants."

Ivan cast Miles a slightly dirty look, for being made the stalking horse, but did not voice an objection.

"The ghem-lords sometimes do," said Maz, "but not the haut-lords, and most certainly never the Imperial Household. They consider each servitor as much a work of art as any of the other objects with which they surround themselves. Everything in the Celestial Garden must be unique, if possible hand-made, and perfect. That applies to their biological con-

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structs as well. They leave mass production to the masses. I'm not sure if it's a virtue or a vice, the way the haut do it, but in a world flooded with virtual realities and infinite duplication, it's strangely refreshing. If only they weren't such awful snobs about it."

"Speaking of things artistic," said Miles, "you said you had some luck identifying that icon?"

"Yes." Her gaze flicked up to fix on his face. "Where did you say you saw it, Lord Vorkosigan?"

"I didn't."

"Hm." She half-smiled, but apparently decided not to fence with him over the point just now. "It is the seal of the Star Crèche, and not something I'd expect an outlander to run across every day. In fact, it's not something I'd expect an outlander to run across *any* day. It's most private."

Check. "And hautish?"

"Supremely."

"And, um . . . just what is the Star Crèche?"

"You don't know?" Maz seemed a little surprised. "Well, I suppose you fellows have spent all your time studying Cetagandan military matters."

"A great deal of time, yes," Ivan sighed.

"The Star Crèche is the private name of the haut-race's gene bank."

"Oh, that. I was dimly aware of—do they keep back-up copies of themselves, then?" Miles asked.

"The Star Crèche is far more than that. Among the haut, they don't deal directly with each other to have egg and sperm united and the resulting embryo deposited in a uterine replicator, the way normal people do. Every genetic cross is negotiated and a contract drawn between the heads of the two genetic lines—the Cetagandans call them constellations, though I suppose you Barrayarans would call them clans. That contract in turn must be approved by the emperor, or rather, by the senior female in the emperor's line, and marked by the seal of the Star Crèche. For the last half-century, since the present regime began, that senior female has been haut Lisbet Degtiar, the emperor's mother. It's not just a formality, either. Any genetic alterations—and the haut do a lot of them—have to be examined and cleared by the empress's board of geneticists, before they are allowed into the haut genome. You asked me if the haut-women had any power. The dowager empress had final approval or veto over every haut birth."

"Can the emperor override her?"

Maz pursed her lips. "I truly don't know. The haut are incredibly reserved about all this. If there are any behind-the-scenes power struggles, the news certainly doesn't leak out past the Celestial Garden's gates. I do know I've never heard of such a conflict."

"So . . . who is the new senior female? Who inherits the seal?"

"Ah! Now you've touched on something interesting." Maz was warming to her subject. "Nobody knows, or at least, the emperor hasn't made the public announcement. The seal is supposed to be held by the emperor's mother if she lives, or by the mother of the heir-apparent if the dowager is deceased. But the Cetagandan emperor has not yet selected his heir.

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The seal of the Star Crèche and all the rest of the empress's regalia is supposed to be handed over to the new senior female as the last act of the funeral rites, so he has ten more days to make up his mind. I imagine that decision is the focus of a great deal of attention right now, among the haut-women. No new genomic contracts can be approved until the transfer is completed."

Miles puzzled this through. "He has three young sons, right? So he must select one of their mothers."

"Not necessarily," said Maz. "He could hand things over to an imperial aunt, one of his mother's kin, as an interim move."

A diffident rap at Miles's door indicated the arrival of the tea. The Barrayaran embassy's kitchen had sent along a perfectly redundant three-tiered tray of little petit fours as well. Someone had been doing their homework, for Maz murmured, "Ooh, my favorite." One feminine hand dove for some dainty chocolate confections despite the imperial luncheon they'd recently consumed. The embassy steward poured tea, opened the wine, and withdrew as discreetly as he had entered.

Ivan took a gulp from his crystal cup, and asked in puzzlement, "Do the haut-lords marry, then? One of these genetic contracts must be the equivalent of a marriage, right?"

"Well . . . no." Maz swallowed her third chocolate morsel and chased it with tea. "There are several kinds of contracts. The simplest is for a sort of one-time usage of one's genes. A single child is created, who becomes the—I hesitate to use the term *property*—who is registered with the constellation of the male parent, and is raised in his constellation's crèche. You understand, these decisions are not made by the principals—in fact, the two parents may never even meet each other. These contracts are chosen by the most senior level of the constellation, the oldest and presumably wisest heads, with an eye to either capturing a favored genetic line, or setting up for a desirable cross in the ensuing generation.

"At the other extreme is a lifetime monopoly—or longer, in the case of imperial crosses. When a haut-woman is chosen to be the mother of a potential heir, the contract is absolutely exclusive—she must never have contracted her genome previously, and can never do so again, unless the emperor chooses to have more than one child by her. She goes to live in the Celestial Garden, in her own pavilion, for the rest of her life."

Miles grimaced. "Is that a reward, or a punishment?"

"It's the best shot at power a haut-woman can ever get—a chance of becoming a dowager empress, if her son—and it's always and only a son—is ultimately chosen to succeed his father. Even being the mother of one of the losers, a prince-candidate or satrap governor, is no bad deal. It's also why, in an apparently patriarchal culture, the output of the haut-constellations is skewed to girls. A constellation head—clan chief, in Barrayaran terminology—can never become an emperor or the father of an emperor, no matter how brightly

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his sons may shine. But through his daughters, he has a chance to become the grandfather of one. Advantages, as you may imagine, then accrue to the dowager empress's constellation. The Degtiar were not particularly important until fifty years ago."

"So the emperor has sons," Miles worked this out, "but everyone else is mad for daughters. But only once or twice a century, when a new emperor succeeds, can anyone win the game."

"That's about right."

"So . . . where does sex fit into all this?" asked Ivan plaintively.

"Nowhere," said Maz.

"Nowhere!"

Maz laughed at his horrified expression. "Yes, the haut have sexual relations, but it's purely a social game. They even have long-lasting sexual friendships that could almost qualify as marriages, sometimes. I was about to say there's nothing formalized, except that the etiquette of all the shifting associations is so incredibly complex. I guess the word I want is *legalized*, rather than formalized, because the rituals are intense. And weird, really weird, sometimes, from what little I've been able to gather of it all. Fortunately, the haut are such racists, they almost never go slumming outside of their genome, so you are not likely to encounter those pitfalls personally."

"Oh," said Ivan. He sounded a little disappointed. "But if the haut don't marry and set up their own households, when and how do they leave home?"

"They never do."

"Ow! You mean they live with, like, their mothers, forever?"

"Well, not with their mothers, of course. Their grandparents or great-grandparents. But the youth—that is, anyone under fifty or so—do live as pensioners of their constellation. I wonder if that is at the root of why so many older haut become reclusive. They live apart because they finally *can*."

"But—what about all those famous and successful ghem-generals and ghem-lords who've won haut-lady wives?" asked Miles.

Maz shrugged. "They can't all aspire to become imperial mothers, can they? Actually, I would point out this aspect particularly to you, Lord Vorkosigan. Have you ever wondered how the haut, who are not noted for their military prowess, control the ghem, who are?"

"Oh, yes. I've been expecting this crazy Cetagandan double-decked aristocracy to fall apart ever since I learned about it. How can you control guns with, with, art contests? How can a bunch of perfumed poetasters like the haut-lords buffalo whole ghem-armies?"

Maz smiled. "The Cetagandan ghem-lords would call it the loyalty justly due to superior culture and civilization. The fact is that anyone who's competent enough or powerful enough to pose a threat gets genetically co-opted. There is no higher reward in the Cetagandan system than to be imperially assigned a haut-lady wife. The ghem-lords are all panting for it. It's the ultimate social and political coup."

"You're suggesting the haut control

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the ghem through these wives?" said Miles. "I mean, I'm sure the haut-women are lovely and all, but the ghem-generals can be such hard-bitten cast-iron bastards—I can't imagine anyone who gets to the top in the Cetagandan Empire being that susceptible."

"If I knew how the haut-women do it," Maz sighed, "I'd bottle it and sell it. No, better—I think I'd keep it for myself. But it seems to have worked for the last several hundred years. It is not, of course, the *only* method of imperial control, to be sure. Only the most overlooked one. I find that, in itself, significant. The haut are nothing if not subtle."

"Does the, uh, haut-bride come with a dowry?" Miles asked.

Maz smiled again, and polished off another chocolate confection. "You have hit upon an important point, Lord Vorkosigan. She does not."

"I'd think keeping a haut-wife in the style to which she is accustomed could get rather expensive."

"Very."

"So . . . if the Cetagandan emperor wished to depress an excessively successful subject, he could award him a few haut-wives and bankrupt him?"

"I . . . don't think it's done quite so obviously as all that. But the element is there. You are very acute, my lord."

Ivan asked, "But how does the haut-lady who gets handed out like a good-conduct medal feel about it all? I mean . . . if the highest haut-lady ambition is to become an imperial monopoly, this has got to be the ultimate opposite. To be permanently dumped out of the haut-genome—their descendants never marry back into the haut, do they?"

"No," confirmed Maz. "I believe the psychology of it all is a bit peculiar. For one thing, the haut-bride immediately outranks any other wives the ghem-lord may have acquired, and her children automatically become his heirs. This can set up some interesting tensions in his household, particularly if it comes, as it usually does, in mid-life when his other marital associations may be of long standing."

"It must be a ghem-lady's nightmare, to have one of these haut-women dropped on her husband," Ivan mused. "Don't they ever object? Make their husbands turn down the honor?"

"Apparently, it's not an honor one can refuse."

"Mm." With difficulty, Miles pulled his imagination away from these side-fascinations, and back to his most immediate worry. "That seal of the Star Crèche thing—I don't suppose you have a picture of it?"

"I brought a number of vids with me, yes, my lord," said Maz. "With your permission, we can run them on your comconsole."

Ooh, I adore competent women. Do you have a younger sister, mi-lady Maz? "Yes, please," said Miles.

They all trooped over to the chamber's comconsole desk, and Maz began a quick illustrated lecture on haut crests and the several dozen assorted imperial seals. "Here it is, my lord—the seal of the Star Crèche."

It was a clear cubical block, measuring maybe fifteen centimeters on a

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side, with the bird-pattern incised in red lines upon its top. *Not* the mysterious rod. Miles exhaled with relief. The terror that had been riding him ever since Maz had mentioned the seal, that he and Ivan might have accidentally stolen a piece of the imperial regalia, faded. The rod was some kind of imperial gizmo, obviously, and would have to be returned—anonymously, by preference—but at least it wasn't—

Maz called up the next unit of data, "And *this* object is the Great Key of the Star Crèche, which is handed over along with the seal," she went on.

Ivan choked on his wine. Miles, faint, leaned on the desk and smiled fixedly at the image of the rod. The original lay some few centimeters under his hand, in the drawer.

"And, ah—just what *is* the Great Key of the Star Crèche, m'la—Maz?" Miles managed to murmur. "What does it do?"

"I'm not quite sure. At one time in the past, I believe it had something to do with data retrieval from the haut gene banks, but the actual device may only be ceremonial by now. I mean, it's a couple of hundred years old. It has to be obsolete."

We hope. Thank God he hadn't dropped it. Yet. "I see."

"Miles. . . ." muttered Ivan.

"Later," Miles hissed to him out of the corner of his mouth. "I understand your concern."

Ivan mouthed something obscene at him, over the seated Maz's head.

Miles leaned against the comconsole desk, and screwed up his features in a realistic wince.

"Something wrong, my lord?" Maz glanced up, concerned.

"I'm afraid my legs are bothering me, a bit. I had probably better pay another visit to the embassy physician, after this."

"Would you prefer to continue this later?" Maz asked instantly.

"Well . . . to tell you the truth, I think I've had about all the etiquette lessons I can absorb for one afternoon."

"Oh, there's *lots* more." But apparently he was looking realistically pale, too, for she rose, adding, "Far too much for one session, to be sure. Are your injuries much troubling you? I didn't realize they were that severe."

Miles shrugged, as if in embarrassment. After a suitable exchange of parting amenities, and a promise to call on his Vervani tutor again very soon, Ivan took over the hostly duties, and escorted Maz back downstairs.

He returned immediately, to seal the door behind him and pounce on Miles. "Do you have any idea how much trouble we're in?" he cried.

Miles sat before the comconsole, rereading the official, and entirely inadequate, description of the Great Key, while its image floated hauntingly before his nose above the vid plate. "Yes. I also know how we're going to get out of it. Do you know as much?"

This gave Ivan pause. "What else do you know that I don't?"

"If you will just leave it to me, I believe I can get this thing back to its rightful owner with no one the wiser."

"It's rightful owner is the Cetagan-

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dan emperor, according to what Maz said."

"Well, ultimately, yes. I should say, back to its rightful keeper. Who, if I read the signs right, is as chagrined about losing it as we are in finding it. If I can get it back to her quietly, I don't think she's going to go around proclaiming how she lost it. Although . . . I do wonder how she *did* lose it." Something was not adding up, just below his level of conscious perception.

"We mugged an Imperial servitor, that's how!"

"Yes, but what was Ba Lura doing with the thing on an orbital transfer station in the first place? Why had it disabled the security monitors in the docking bay?"

"Lura was taking the Great Key somewhere, obviously. To the Great Lock, for all I know." Ivan paced around the comconsole. "So the poor sod cuts its throat the next morning 'cause it lost its charge, its trust, courtesy of us—hell, Miles. I feel like we just killed that old geezer. And it never did us any harm, it just blundered into the wrong place and had the bad luck to startle us."

"Is that what happened?" Miles murmured. "Really . . . ?" *Is that why I am so desperately determined for the story to be something, anything, else?* The scenario hung together. The old Ba, charged with transporting the precious object, loses the Great Key to some outlander barbarians, confesses its disgrace to its mistress, and kills itself in expiation. Wrap. Miles felt ill. "So . . . if the key was that important, why wasn't the Ba traveling with a squadron of imperial ghemguards?"

"*God* Miles, I wish it *had* been!"

A firm knock sounded on Miles's door. Miles hastily shut down the comconsole and unsealed the door lock. "Come in."

Ambassador Vorob'yev entered, and favored him with a semi-cordial nod. He held a sheaf of delicately colored, scented papers in his hand.

"Hello, my lords. Did you find your tutorial with Maz useful?"

"Yes, sir," said Miles.

"Good. I thought you would. She's excellent." Vorob'yev held up the colored papers. "While you were in session, this invitation arrived for you both, from Lord Yenaro. Along with assorted profound apologies for last night's incident. Embassy security has opened, scanned, and chemically analyzed it. They report the organic esters harmless." With this safety pronouncement, he handed the papers across to Miles. "It is up to you, whether or not to accept. If you concur that the unfortunate side-effect of the sculpture's power field was an accident, your attendance might be a good thing. It would complete the apology, repairing face all around."

"Oh, we'll go, sure." The apology and invitation were hand-calligraphed in the best Cetagandan style. "But I'll keep my eyes open. Ah . . . wasn't Colonel Vorreedi due back today?"

Vorob'yev grimaced. "He's run into some tedious complications. But in view of that odd incident at the Marilacan embassy, I've sent a subordinate to replace him. He should be back tomorrow. Perhaps . . . do you wish a

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bodyguard? Not openly, of course, that would be another insult."

"Mm . . . we'll have a driver, right? Let him be one of your trained men, have back-up on call, give us both comm links, and have him wait for us nearby."

"Very well, Lord Vorkosigan. I'll make arrangements," Vorob'yev nodded. "And—regarding the incident in the rotunda earlier today—"

Miles's heart pounded. "Yes?"

"Please don't break ranks like that again."

"Did you receive a complaint?" *And from whom?*

"One learns to interpret certain pained looks. The Cetagandans would consider it impolite to protest—but should unpleasant incidents pile high enough, not too impolite for them to take some sort of indirect and arcane retaliation. You two will be gone in ten days, but I will still be here. Please don't make any job any more difficult than it already is, eh?"

"Understood, sir," said Miles brightly. Ivan was looking intensely worried—was he going to bolt, pour out confessions to Vorob'yev? Not yet, evidently, for the ambassador waved himself back out without Ivan throwing himself at his feet.

"*Nearby* doesn't cut it, for a bodyguard," Ivan pointed out, as soon as the door sealed again.

"Oh, you're beginning to see it my way now, are you? But if we go to Yenaro's at all, I can't avoid risk. I have to eat, drink, and breathe—all routes for attack an armed guard can't do much about. Anyway, my greatest defense is that it would be a grievous insult to the Cetagandan emperor for anyone to seriously harm a galactic delegate to his august mother's funeral. I predict, should another accident occur, it will be equally subtle and non-fatal." *And equally infuriating.*

"Oh, yeah? When there's been one fatality already?" Ivan stood silent for a long time. "Do you think . . . all these incidents could possibly be related?" Ivan nodded toward the perfumed papers still in Miles's hand, and toward the comconsole desk drawer. "I admit, I don't see how."

"Do you think they could possibly all be unrelated coincidences?"

"Hm." Ivan frowned, digesting this. "So tell me," he pointed again to the desk drawer, "How *are* you planning to get rid of the empress's dildo?"

Miles's mouth twitched, stifling a grin at the Ivan-diplomatic turn of phrase. "I can't tell you." *Mostly because I don't know yet myself.* But the haut Rian Degtiar had to be scrambling, right now. He fingered, as if absently, the silver eye-of-Horus ImpSec insignia pinned to his black collar. "There's a lady's reputation involved."

Ivan's eyes narrowed in scorn of this obvious appeal to Ivan's own brand of personal affairs. "Horseshit. *Are* you running some kind of secret rig for Simon Illyan?"

"If I were, I couldn't tell you, now could I?"

"I'm damned if I know." Ivan stared at him in frustration for another moment, then shrugged. "Well, it's your funeral."

* * *

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"Stop here," Miles instructed the ground-car's driver. The car swung smoothly to the side of the street and with a sigh of its fans settled to the pavement. Miles peered at the layout of Lord Yenaro's suburban mansion in the gathering dusk, mentally pairing the visual reality with the map he had studied back at the Barrayaran embassy.

The barriers around the estate, serpentine garden walls and concealing landscaping, were visual and symbolic rather than effective. The place had never been designed as a fortress of anything but privilege. A few higher sections of the rambling house glimmered through the trees, but even they seemed to focus inward rather than outward.

"Comm link check, my lords?" the driver requested. Miles and Ivan both pulled the devices from their pockets and ran through the codes with him. "Very good, my lords."

"What's our back-up?" Miles asked him.

"I have three units, arranged within call."

"I trust we've included a medic."

"In the lightflyer, fully equipped. I can put him down inside Lord Yenaro's courtyard in forty-five seconds."

"That should be sufficient. I don't expect a frontal assault. But I wouldn't be surprised if I encountered another little 'accident' of some sort. We'll walk from here, I think. I want to get the feel of the place."

"Yes, my lord." The driver popped the canopy for them, and Miles and Ivan exited.

"Is this what you call genteel poverty?" Ivan inquired, looking around as they strolled through open, unguarded gates and up Yenaro's curving drive.

Ah yes. The style might be different, but the scent of aristocratic decay was universal. Little signs of neglect were all around: unrepaired damage to the gates and walls, overgrown shrubbery, what appeared to be three-quarters of the mansion dark and closed-off.

"Vorob'yev had the embassy's ImpSec office make a background check of Lord Yenaro," Miles said. "Yenaro's grandfather, the failed ghem-general, left him the house but not the means to keep it up, having consumed his capital in his extended and presumably embittered old age. Yenaro's been in sole possession for about four years. He runs with an artsy crowd of young and unemployed ghem-lordlings, so his story holds up to that extent. But that thing in the Marilacan embassy's lobby was the first sculpture Yenaro's ever been known to produce. Curiously advanced, for a first try, don't you think?"

"If you're so convinced it was a trap, why are you sticking your hand in to try and trip another one?"

"No risk, no reward, Ivan."

"Just what reward are you envisioning?"

"Truth. Beauty. Who knows? Embassy security is also running a check on the workmen who actually built the sculpture. I expect it to be revealing."

At least he could make that much use of the machinery of ImpSec. Miles

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felt intensely conscious of the rod now riding concealed in his inner tunic pocket. He'd been carrying the Great Key in secret all day, through a tour of the city and an interminable afternoon performance of a Cetagandan classical dance company. This last treat had been arranged by imperial decree especially for the off-planet envoys to the funeral. But the haut Rian Degtiar had not made her promised move to contact him yet. If he did not hear from his haut-lady by tomorrow.... On one level, Miles was growing extremely sorry he had not taken the local ImpSec subordinates into his confidence on the very first day. But if he had, he would no longer be in charge of this little problem; the decisions would all have been hiked to higher levels, out of his control. *The ice is thin. I don't want anyone heavier than me walking on it just yet.*

A servant met them at the mansion's door as they approached, and escorted them into a softly-lit entry foyer where they were greeted by their host. Yenaro was in dark robes similar to the ones he'd worn at the Marilacan embassy's reception; Ivan was clearly correct in his undress greens. Miles had chosen his ultra-formal House blacks. He wasn't sure how Yenaro would interpret the message, as honor, or reminder—*I'm the official envoy*, or warning—*don't mess with me*. But he was fairly certain it was not a nuance Yenaro would miss.

Yenaro glanced down at Miles's black boots. "And are your legs better now, Lord Vorkosigan?" he inquired anxiously.

"Much better, thank you," Miles smiled tightly in return. "I shall certainly live."

"I'm so glad." The tall ghem-lord led them around a few corners and down a short flight of steps to a large semi-circular room wrapped around a peninsula of the garden, as if the house were undergoing some botanical invasion. The room was somewhat randomly furnished, apparently with items Yenaro had previously owned rather than to design; but the effect was pleasantly comfortable-bachelor. The lighting here, too, was soft, camouflaging shabbiness. A dozen ghem-types were already present, talking and drinking. The men outnumbered the women; two bore full face paint, most sported the cheek-decal of the younger set, and a few radical souls wore nothing above the neck but a little eye makeup. Yenaro introduced his Barrayaran exotics all around. None of the ghem were anyone Miles had heard of or studied, though one young man claimed a great-uncle on staff at Cetagandan headquarters.

An incense burner smoked on a cylindrical stand by the garden doors; one ghem-guest paused to inhale deeply. "Good one, Yenaro," he called to his host. "Your blend?"

"Thank you, yes," said Yenaro.

"More perfumes?" inquired Ivan.

"And a bit extra. That mixture also contains a mild relaxant suitable to the occasion. You would perhaps not care for it, Lord Vorkosigan."

Miles smiled stiffly. Just how much of an organic chemist was this man? Miles was reminded that the root

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word of *intoxication* was *toxic*. "Probably not. But I'd love to see your laboratory."

"Would you? I'll take you up, then. Most of my friends have no interest in the technical aspects, only in the results."

A young woman, listening nearby, drifted up at this and tapped Yenaro on the arm with one long fingernail, glittering with patterned enamel. "Yes, dear Yenni, results. You promised me some, remember?" She was not the prettiest ghem-woman Miles had seen, but attractive enough in swirling jade-green robes, with thick pale hair clipped back and curling down to her shoulders in a pink-frosted froth.

"And I keep my promises," Lord Yenaro asserted. "Lord Vorkosigan, perhaps you would care to accompany us upstairs now?"

"Certainly."

"I'll stay and make new acquaintances, I think," Ivan bowed himself out of the party. The two tallest and most striking ghem-women present, a leggy blonde and a truly incredible redhead, were standing together across the room; Ivan somehow managed to make eye contact with both, and they favored him with inviting smiles. Miles sent up a short silent prayer to the guardian god of fools, lovers, and madmen, and turned to follow Yenaro and his female petitioner.

Yenaro's organic chemistry laboratory was sited in another building; lights came up as they approached across the garden. It proved to be a quite respectable installation, a long double room on the second floor—some of the money that wasn't going into home repairs was obviously ending up here. Miles walked around the benches, eyeing the molecular analyzers and computers while Yenaro rummaged among an array of little bottles for the promised perfume. All the raw materials were beautifully-organized in correct chemical groupings, betraying a deep understanding and detailed love of the subject on the owner's part.

"Who assists you here?" Miles inquired.

"No one," said Yenaro. "I can't bear to have anyone else mucking about. They mess up my orderings, which I sometimes use to inspire my blends. It's not all science, you know."

Indeed. With a few questions, Miles led Yenaro on to talk about how he'd made the perfume for the woman. She listened for a while and then wandered off to sniff at experimental bottles, till Yenaro, with a pained smile, rescued them from her. Yenaro's expertise was less than professorial, but fully professional; any commercial cosmetics company would have hired him on the spot for their product development laboratory. So, and so. How did this square with the man who'd claimed *Hands are to be hired*?

Not at all, Miles decided with concealed satisfaction. Yenaro was unquestionably an artist, but an artist of esters. Not a sculptor. Someone else had supplied the undoubted technical expertise that had produced the fountain. And had that same somebody else supplied the technical informa-

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tion on Miles's personal weaknesses? *Let's call him . . . Lord X.* Fact One about Lord X: he had access to Cetagandan Security's most detailed reports on Barrayarans of military or political significance . . . and their sons. Fact Two: he had a subtle mind. Fact Three . . . there was no fact three. Yet.

They returned to the party to find Ivan ensconced on a couch between the two women, entertaining them—or at least, they were laughing encouragingly. The ghem-women fully matched Lady Gelle in beauty; the blonde might have been her sister. The redhead was even more arresting, with a cascade of amber curls falling past her shoulders, a perfect nose, lips that one might—Miles cut off the thought. No ghem-lady was going to invite *him* to dive into her dreams.

Yenaro departed briefly to oversee his servant—he seemed to have only one—and expedite the smooth arrival of fresh food and drinks. He returned with a small transparent pitcher of a pale ruby liquid. "Lord Vorpatril," he nodded at Ivan. "I believe you appreciate your beverages. Do try this one."

Miles went to alert-status, his heart thumping. Yenaro might not be a sculptor-assassin, but he would undoubtedly make a great poisoner. Yenaro poured from the pitcher into three little cups on a lacquered tray, and extended the tray to Ivan.

"Thanks." Ivan selected one at random.

"Oh, zlati ale," murmured one of the junior ghem-lords. Yenaro passed the tray to him, and took the last cup himself. Ivan sipped and raised his brows in surprised approval. Miles watched closely to be sure Yenaro actually swallowed. He did. Five different methods for presenting deadly drinks with just that maneuver and still being sure the victim received the right one, including the trick of the host consuming the antidote first, flashed through Miles's mind. But if he was going to be that paranoid, they ought not have come here in the first place. Yet he'd eaten and drunk nothing himself so far. *So what are you going to do, wait and see if Ivan falls over first, and then try it?*

Yenaro did not, this time, pause to confide to the two women bracketing Ivan the repulsive biological history of his birth. Hell. Maybe the incident with the fountain really had been an accident, and the man was sorry, and trying his very best to make it up to the Barrayarans. Nevertheless, Miles circled in, trying to get a closer look at Ivan's cup over his shoulder.

Ivan was in process of the classic *I'm just resting my arm along the back of this couch* test of the redhead on his right, to see if she was going to flinch from or invite further physical contact. Ivan swiveled his head to repel his cousin with a toothy smile. "Go have a good time, Miles," he murmured. "Relax. Stop breathing up my neck."

Miles grimaced back in non-appreciation of the height-humor, and drifted off again. Some people just didn't want to be saved. He decided instead to try to talk with some of Yenaro's male friends, several of whom

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were clustered in the opposite end of the room.

It wasn't hard to get them to talk about themselves. It seemed that was all they had to talk about. Forty minutes of valiant effort in the art of conversation convinced Miles that most of Yenaro's friends had the minds of fleas. The only expertise they displayed was in witty commentary upon the personal lives of their equally idle compatriots: their clothes, various love affairs and the mismanagement thereof, sports—all spectator, none participatory, and mainly of interest due to wagers on the outcome—and the assorted latest commercial feelie dreams and other offerings, including erotic ones. This retreat from reality seemed to absorb by far the bulk of the ghem-lordlings' time and attention. Not one of them offered a word about anything of political or military interest. Hell, *Ivan* had more mental clout.

It was all a bit depressing. Yenaro's friends were excluded men, wasted wastrels. No one was excited about a career or service—they had none. Even the arts received only a ripple of interest. They were strictly feelie dream consumers, not producers. All in all, it was probably a good thing these youths had no political interests. They were just the sort of people who started revolutions but could not finish them, their idealism betrayed by their incompetence. Miles had met similar young men among the Vor, third or fourth sons who for whatever reason had not gained entry to a traditional military career, living as pensioners upon their families, but even they could look forward to some change in their status by mid-life. Given the average ghem life span, any chance of ascent up the social ladder by inheritance was still some eighty or ninety years off for most of Yenaro's set. They weren't inherently stupid—their genetics did not permit it—but their minds were tamped down to some artificial horizon. Beneath the air of hectic sophistication, their lives were frozen in place. Miles almost shivered.

Miles decided to try out the women, if Ivan had left any for him. He excused himself from the group to pursue a drink—he might have left without explanation just as easily, for all anyone seemed to care about Lord Yenaro's most unusual, and shortest, guest. Miles helped himself at a bowl from which everyone else seemed to be ladling their drinks, and touched the cup to his lips, but did not swallow. He looked up to find himself under the gaze of a slightly older woman who had come late to the party with a couple of friends, and who had been lingering quietly on the fringes of the gathering. She smiled at him.

Miles smiled back, and slid around the table to her side, composing a suitable opening line. She took the initiative from him.

"Lord Vorkosigan. Would you care to take a walk in the garden with me?"

"Why . . . certainly. Is Lord Yenaro's garden a sight to see?" *In the dark?*

"I think it will interest you." The smile dropped from her face as if wiped away with a cloth the moment

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she turned her back to the room, to be replaced with a look of grim determination. Miles fingered the comm link in his trouser pocket, and followed in the perfumed wake of her robes. Once out of sight of the room's glass doors among the neglected shrubbery, her step quickened. She said nothing more. Miles limped after her. He was unsurprised when they came to a red enameled, squared-linteled gate and found a person waiting, a slight, androgynous shape with a dark hooded robe protecting its bald head from the night's gathering dew.

"The ba will escort you the rest of the way," said the woman.

"The rest of the way where?"

"A short walk," the ba spoke in a soft alto.

"Very well," Miles held up a restraining hand, and drew his comm link from his pocket, and spoke into it. "Base. I'm leaving Yenaro's premises for a while. Track me, but don't interrupt me unless I call for you."

The driver's voice came back in a dubious tone. "Yes, my lord . . .where are you going?"

"I'm . . . taking a walk with a lady. Wish me luck."

"Oh." The driver's tone grew more amused, less dubious. "Good luck, my lord."

"Thank you." Miles closed the channel. "All right."

The woman seated herself on a rickety bench and drew her robes around herself with the air of one preparing for a lengthy wait. Miles followed the ba out the gate and past another residence, across a roadway, and into a shallow wooded ravine. The ba produced a hand-light to prevent stumbles on rocks and roots, politely playing it before Miles's polished boots, which were going to be a lot less polished if this went on very far. They climbed up out of the ravine into what was obviously the back portion of another suburban estate in an even more neglected condition than Yenaro's.

A dark bulk looming through the trees was an apparently-deserted house. But they turned right on an overgrown path, the ba pausing to sweep damp branches out of Miles's way, and then back down toward the stream. They emerged in a wide clearing where a wooden pavilion stood—some ghem-lord's former favorite picnic spot for *al fresco* brunches, no doubt. Duckweed choked a pond, crowding out a few sad water-irises. They crossed the pond on an arched foot-bridge, which creaked so alarmingly Miles was momentarily glad he was no bigger. A faint, familiar pearlescent glow emanated from the pavilion's vine-veiled openings. *Right. This is it.*

The ba servitor pulled aside some greenery, gestured Miles inside, and went to stand guard by the foot-bridge. Cautiously, Miles stepped within the small, one-roomed building.

The haut Rian Degtiar or a close facsimile sat, or stood, or something, the usual few centimeters above the floor, a blank pale sphere. She had to be riding in a float-chair. Her light seemed dimmed, stopped down to a furtive feeble glow. *Wait. Let her*

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make the first move. The moment stretched. Miles began to be afraid this conversation was going to be as disjointed as their first one, but then she spoke, in the same breathless, transmission-flattened voice he had heard before. "Lord Vorkosigan. I have contacted you as I said I would, to make arrangements for the safe return of my . . . thing."

"The Great Key," said Miles.

"You know what it is now?"

"I've been doing a little research, since our first chat."

She moaned. "What do you want of me? Money? I have none. Military secrets? I know none."

"Don't go coy on me, and don't panic. I want very little." Miles unshipped his tunic, and drew out the Great Key.

"Oh, you have it *here!* Oh, give it to me!" The pearl bobbed forward.

Miles stepped back. "Not so fast. I've kept it safe, and I'll give it back. But I feel I should get something in return. I merely want to know exactly how it came to be delivered, or misdelivered, into my hands, and why."

"It's no business of yours, Barrayaran!"

"Perhaps not. But every instinct I own is crying out that this is some kind of set-up, of me, or of Barrayar through me, and as a Barrayaran Imp-Sec officer that makes it very explicitly my business. I'm willing to tell you everything I saw and heard, but you must return the favor. To start with, I want to know what Ba Lura was doing with a piece of the late empress's major regalia on a space station."

Her voice went low and tart. "Stealing it. Now give it back."

"A key. A key is not of great worth without a lock. I grant it's a pretty elegant historical artifact, but if Ba Lura was planning on a privately-funded retirement, surely there are more valuable things to steal from the Celestial Garden. And ones less certain to be missed. Was Lura planning to blackmail you? Is that why you murdered it?" A completely absurd charge—the haut-lady and Miles were each other's alibis—but he was curious to see what it would stir up in the way of response.

The reaction was instantaneous. "You vile little—! I did not drive Lura to its death. If anything, you are responsible!"

God, I hope not. "This may be so, and if it is, *I must know.* Lady—there is no Cetagandan security within ten kilometers of us right now, or you could have them strip this bauble off me and dump my carcass in the nearest alleyway right now. Why not? *Why* did Ba Lura steal the Great Key, for its pleasure? The Ba makes a hobby of collecting Cetagandan Imperial regalia, does it?"

"You are horrible!"

"Then to whom was Ba Lura taking the thing to sell?"

"*Not* sell!"

"Ha! Then you know who!"

"Not exactly. . ." she hesitated. "Some secrets are not mine to give. They belong to the Celestial Lady."

"Whom you serve."

"Yes."

"Even in death."

"Yes." A note of pride edged

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her voice.

"And whom the Ba betrayed. Even in death."

"No! Not betrayed. . . . We had a disagreement."

"An honest disagreement?"

"Yes."

"Between a thief and a murderess?"

"No!"

Quite so, but the accusation definitely had her going. Some guilt, there. *Yeah, tell me about guilt.* "Look, I'll make it easy for you. I'll begin. Ivan and I were coming over from the Barrayaran courier jumpship in a personnel pod. We docked into this dump of a freight bay. The Ba Lura, wearing a station employee uniform and some badly-applied false hair, lumbered into our pod as soon as the lock cycled open, and reached, we thought, for a weapon. We jumped it, and took away a nerve disruptor and this." Miles held up the Great Key. "The Ba shook us off and escaped, and I stuck this in my pocket till I could find out more. The next time I saw the Ba it was dead in a pool of its own blood on the floor of the funeral rotunda. I found this unnerving, to say the least. Now it's your turn. You say Ba Lura stole the key from your charge. When did you discover the Great Key was missing?

"I found it missing from its place, that day."

"How long could it have been gone? When had you last checked it?"

"It is not being used every day now, because of the period of mourning for the Celestial Lady. I had last seen it when I arranged her regalia two days before that."

"So potentially, it could have been missing for three days before you discovered its absence. When did the *Ba* go missing?"

"I'm . . . not sure. I saw Ba Lura the evening before."

"That cuts it down a little. So the Ba could have been gone with the key as early as the previous night. Do the ba servitors pass pretty freely in and out of the Celestial Garden, or is it hard?"

"Freely. They run all our errands."

"So Ba Lura came back . . . when?"

"The night of your arrival. But the Ba would not see me. It claimed to be sick. I could have had it dragged into my presence, but . . . I did not want to inflict such an indignity."

They were in it together, right.

"I went to see the Ba in the morning. The whole sorry story came out, then. The Ba was trying to take the Great Key to . . . someone, and entered into the wrong docking bay."

"Then *someone* was supposed to supply a personnel pod? Then *someone* was waiting on a ship in orbit?"

"I didn't say that!"

Keep pressing her. It's working. Though it did make him feel faintly guilty, to be badgering the distraught old lady so, even if possibly for her own good. *Don't let up.* "So the Ba blundered onto our pod, and—what was the rest of its story? Tell me exactly!"

"Ba Lura was attacked by Barrayaran soldiers, who stole the Great Key."

"How many soldiers?"

"Six."

Miles's eyes widened in delight.

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"And then what?"

"Ba Lura begged for its life, and head and honor, but they laughed and ejected the Ba, and flew away."

Lies, lies at last. And yet . . . the Ba was only human. Anyone who had screwed up so hugely might retell the story so as to make themselves look less at fault. "What exactly did it say we said?"

Her voice grated with anger. "You insulted the Celestial Lady."

"Then what?"

"The Ba came home in shame."

"So, why didn't the Ba call on Cetagandan security to shake us down and get the Great Key back on the spot?"

There was a longer silence. Then she said, "The Ba could not do that. But it confessed to me. And I came to you. To . . . humble myself. And beg for the return of my . . . charge and my honor."

"Why didn't the Ba confess to you the night before?"

"I don't know!"

"So while you set about your retrieval task, Ba Lura cut its throat."

"In great grief and shame," she said lowly.

"Yeah? Why not at least wait to see if you could coax the key back from me? So why not cut its throat privately, in its own quarters? Why advertise its shame to the entire galactic community? Isn't that a bit *unusual?* Was the Ba supposed to attend the bier-gifting ceremony?"

"Yes."

"And you were too?"

"Yes. . . ."

"And you believed the Ba's story?"

"Yes!"

"Lady, I think you are lost in the woods. Let me tell you what happened in the personnel pod as *I* saw it. There were no six soldiers. Just me, my cousin, and the pod pilot. There was no conversation, no begging or pleading, no slurs on the Celestial Lady. Ba Lura just yelped, and ran off. It didn't even fight very hard. In fact, it scarcely fought us at all. Strange, don't you think, in a hand-to-hand struggle for something so important that the Ba slit its own throat over its loss the next day? We were left scratching our heads, holding the damned thing and wondering what the hell? Now you know that one of us, me or the Ba, is lying. I know which one."

"Give the Great Key to me," was all she could say. "It's not yours."

"But I think I was framed. By someone who apparently wants to drag Barrayar into a Cetagandan internal . . . disagreement. *Why?* What am I being set up *for?*"

Her silence might indicate that these were the first new thoughts to penetrate her panic in two days. Or . . . it might not. In any case, she only whispered, "Not yours!"

Miles sighed. "I couldn't agree with you more, milady, and I am glad to return your charge. But in light of the whole situation, I would like to be able to testify—under fast-penta, if need be—just *who* I gave the Great Key to. You could be anyone, in that bubble. My Aunt Alys, for all I know. Or Cetagandan security, or . . . who knows. I will return it to you—face to face." He held out his hand half-open, the key resting invitingly across

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his palm.

"Is that . . . the last of your price?"

"Yes. I'll ask no more."

It was a small triumph. He was going to see a haut woman, and Ivan wasn't. It would doubtless embarrass the old dragon, to reveal herself to outlander eyes, but dammit, given the run-around Miles had suffered, she owed him something. And he was deathly serious about being able to identify where the Great Key went. The haut Rian Degtiar, Handmaiden of the Star Crèche, was certainly not the only player in this game.

"Very well," she whispered. The white bubble faded to transparency, and was gone from between them.

"Oh," said Miles, in a very small voice.

She sat in a float-chair, clothed from slender neck to ankle in flowing robes of shining white, a dozen shimmering textures lying one atop another. Her hair glinted ebony, masses of it that poured down across her shoulders, past her lap, to coil around her feet. When she stood, it would trail on the floor like a banner. Her enormous eyes were an ice blue of such arctic purity as to make Lady Gelle's eyes look like mud puddles. Skin . . . Miles felt he had never seen skin before, just blotched bags people wore around themselves to keep from leaking. This perfect ivory surface—his hands ached with the desire to touch it, just once, and die. Her lips were warm, as if roses pulsed with blood. . . .

How old was she? Twenty? Forty? This was a haut-woman. Who could tell? Who could care? Men of the old religion had worshipped on their knees icons far less glorious, in beaten silver and hammered gold. Miles was on his knees now, and could not remember how he'd come to be there.

He knew now why they called it "falling in love." There was the same nauseating vertigo of free fall, the same vast exhilaration, the same sick certainty of broken bones upon impact with a rapidly rising reality. He inched forward, and laid the Great Key in front of her perfectly-shaped, white-slippered feet, and sank back, and waited.

I am Fortune's fool. ■

TO BE CONTINUED IN THE NEXT ISSUE.

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Joseph P. Martino

AT LAST: COMPUTERS THAT DO MATH!

In the 1930s and 1940s, when science fiction writers put computers into their stories, they portrayed computers as doing mathematics, that is, doing algebra, geometry, and calculus. They did not portray them as simply giant adding machines. When the first digital computers came along in the 1940s, however, that's exactly what they were—giant adding machines.

Digital computers were initially designed to do calculations—additions and multiplications. The first American digital computer, the ENIAC, was used to calculate ballistics tables. The next few digital computers, developed by the National Bureau of Standards, were used to calculate mathematical tables.

Despite the fact they were essentially giant adding machines, computers still had a major impact on the way scientists did their work. After all, much of data analysis can be reduced to adding and multiplying. Powerful and useful as these digital computers were, however, they presented two problems to the scientist who wanted to use them. First, there was a barrier between the scientist and the computing machine. That barrier was the need to program the machine. While many scientists did learn to program computers, writing programs took time away from doing science. Second, in many cases the scientist wants not a number, but a general formula. Digital computers could do arithmetic, but they couldn't do algebra.

These two problems are now disappearing. Within the past few years, software packages have been developed which allow the scientist to communicate with the computer in familiar mathematical notation rather than in a programming language. Some of these packages can perform symbolic manipulation, including algebra and calculus. These new packages are beginning to have a major

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influence on the way scientists use computers.

A CALCULATING SCRATCH PAD

Mathcad™ is typical of the programs which break through the programming barrier between the scientist and the computer. It allows the scientist to "write" a mathematical expression on what looks like a scratchpad. The program then carries out the indicated operations, which are not limited to simply adding and multiplying.

Let's look at an example. Suppose we have a sounding rocket which is to be launched vertically, to gather data about the upper atmosphere. Its engine is throttled to give a constant acceleration of 2 g's[1]. The rocket burns for 30 seconds. What will be the vertical velocity at burnout? What will be the altitude at burnout?

To find the burnout velocity, we need to integrate the acceleration from time equals zero to 30 seconds. That is, we want:

$$v = \int_0^{30} 19.6\,dt$$

The value of this integral can be approximated by a set of trapezoids with vertical sides, horizontal bottom, and a top of value 19.6 meters/sec^2. Those whose calculus hasn't completely rusted away will recall that the *integral* is defined as the *limit* of a sequence of such approximations, as the width of the trapezoids approaches zero.

Writing a program to compute an approximate value of the integral as the sum of a set of narrow trapezoids is not very difficult. However, writing a program to implement a very accurate algorithm, which can deal with any shape of integrand, is more work than most scientists want or need to undertake. The important point about Mathcad is that the programming is already done, and moreover is hidden behind a simple-appearing "front end." To carry out this integration, the user simply types: [2]

$$g := 9.8\cdot\frac{m}{sec^2}$$

$$v := \int_{0\cdot sec}^{30\cdot sec} 2\cdot g\,dt$$

where ":=" means "is defined as." On the next line the user types the left-hand side of "v = ." Mathcad immediately fills in the right hand side, giving:

$$v = 588\cdot m\cdot sec^{-1}$$

The user thus writes expressions in conventional mathematical notation, and Mathcad takes care of the computations behind the scenes. Note that Mathcad "understands" physical dimensions such as meters and seconds, and deals with them properly.

In similar fashion, we can type in:

$$s := \int_{0\cdot sec}^{30\cdot sec}\int_{0\cdot sec}^{30\cdot sec} 2\cdot g\,dt\,dt$$

and get:

$$s = 1.764\cdot 10^4\cdot m$$

or a burnout altitude of 17.64 kilometers.

But wait, you say. We didn't need Mathcad for that. There are formulas for finding velocity and distance covered at constant acceleration. So let's look at a more realistic example.

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We'll consider another sounding rocket. This sounding rocket is such that 75% of its liftoff weight is fuel. Thrust at liftoff would produce a free-space acceleration of 1.5 *g*'s, giving a net vertical acceleration of 0.5 *g*'s. Therefore, free-space acceleration at burnout would be 6 *g*'s, or a net vertical acceleration of 5 *g*'s. Now we need to integrate a function which changes linearly from 1.5 to 5, over a period of 30 seconds. We type in:

$t := 0 \cdot sec..30 \cdot sec$

$T := 30 \cdot sec$

$acc(t) := g \cdot \left(.5 + 4.5 \cdot \frac{t}{T}\right)$

$v := \int_{0 \cdot sec}^{T} acc(t)\, dt$

$s := \int_{0 \cdot sec}^{T} \int_{0 \cdot sec}^{T} acc(t)\, dt\, dt$

and get:

$v = 643.125 \cdot m \cdot sec^{-1}$

$s = 1.929 \cdot 10^{4} \cdot m$

Note that Mathcad will accept a defined variable as a limit of integration.

Of course even these integrals are fairly straightforward. Let's look at a more complex one.

Consider the following scenario. You are a shuttle rocket pilot on the Moon. Your next mission is to take off from a point on the Moon's equator, and land at another point on the Moon's equator, a quarter of the way around the Moon. Lunar Traffic Control requires that in order to avoid mountains near the take-off and landing points, the ascent angle will be such as to put your rocket 2,500 km from the center of the Moon at the peak of the trajectory (apolune). You need to file a flight plan. How long will the flight take?

The equation for the trajectory can be shown (see below) to be:

$$Rrocket = \frac{1}{9.97634610^{-7} \cdot (1 + .599 \cdot \cos(\theta))}$$

where Rrocket is the radius of the rocket's trajectory as measured from the focus of the ellipse at the center of the Moon, and the angle θ is defined to be zero at the perilune of the trajectory (which is of course unreachable since it's inside the Moon). Peak (apolune) of the trajectory is therefore at θ = 180°. By the symmetry of the ellipse about the apolune, the trajectory then starts at θ = 135° and ends at θ = 225°. Time of flight is given by:

$$time_of_flight = \int_{135\,deg}^{225\,deg} \frac{1}{(.002) \cdot (1 + .599\cos(\theta))^2}\, d\theta$$

That's a deceptively simple-looking integral. Reference to a table of integrals will reveal that the closed-form answer is unpleasantly complex. However, Mathcad and similar programs have no difficulty integrating it numerically. Just type it in as though you were writing it on a scratchpad, and get the result:

$$time_of_flight := \int_{135\,deg}^{225\,deg} \frac{1}{(c1^{3} \cdot G \cdot moonmass)^{0.5} \cdot (1 + c2 \cdot \cos(\theta))^2}\, d\theta$$

$time_of_flight = 3.479\ 10^{3} \cdot sec$

You can file your flight plan for a flight time of just under an hour. Not too bad for a trip a quarter of the way around the Moon. And solving the problem using Mathcad takes much less time than that.

Not only do Mathcad and similar programs solve individual equations, they can solve simultaneous equations. For instance, how can the for-

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mula for the rocket's trajectory be obtained? We know it has to be an ellipse. We know the ellipse is specified by two parameters, the eccentricity and a term related to the radius at

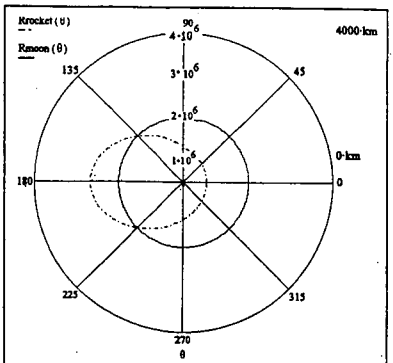

Figure 1:
Trajectory of Moon Rocket

pericenter (the point closest to the focal point from which radius is measured). Therefore if we know two points on the ellipse, the entire equation can be determined.

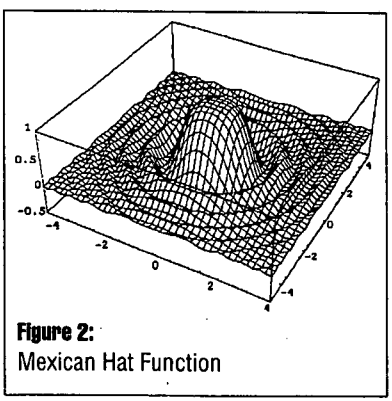

Figure 2:
Mexican Hat Function

But in the rocket problem, we do know two points: launch point and perilune.[3] Hence we could solve two equations in two unknowns simultaneously, and obtain the desired equation (which of course is exactly what I did). The solution involves setting up a "solve block," the start of which is indicated by the command "Given." The solve block includes the equations to be solved simultaneously, and is terminated by the command "Find." The solve block must be preceded by an initial estimate of the unknowns. Here's how the rocket trajectory was determined:

Guess values ecc := .6

$$C := .000001 \cdot \frac{1}{m}$$

Given

$$\frac{1}{C \cdot (1 + ecc \cdot \cos(180 \cdot deg))} = 2.5 \cdot 10^6 \cdot m$$

$$\frac{1}{C \cdot (1 + ecc \cdot \cos(135 \cdot deg))} = 1.739 \cdot 10^6$$

$$\begin{pmatrix} c1 \\ c2 \end{pmatrix} := Find(C, ecc)$$

$c1 = 9.976 \cdot 10^{-7} \cdot m^{-1}$

$c2 = 0.599$

The solutions (c1 and c2) are obtained, not by substituting and eliminating variables, as algebra students are taught to do, but by iteratively altering the initial estimates until all the equations are satisfied.

In addition to crunching numbers, all the mathematical software packages will produce graphs. As an illustration of what is possible, Figure 1 shows the Moon (circle) and the trajectory (ellipse) of the Moon rocket example. Figure 2 shows the so-called "Mexican Hat Function," $\sin(x^2 + y^2)/(x^2 + y^2)$, as plotted by a software package called Mathematica™ (more about it later). The Mexican Hat Function is frequently used to demonstrate

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the plotting capabilities of mathematical software packages.

These examples do not begin to exhaust the capabilities of currently available mathematical software packages. Other capabilities include Fourier analysis, numerically solving differential equations, and working with vectors and matrices. Like the examples shown above, all these capabilities can be called up "from the keyboard" by the individual scientist. No programming is required.

ALGEBRA BY COMPUTER

A math professor of mine used to say, "Mathematics is the art of computing—as little as possible." His point was that mathematicians look for general solutions, often involving variables or adjustable parameters, instead of calculating individual cases. Calculating an individual case may ultimately be necessary for some engineering or scientific purpose, but it tells you nothing about behavior at other than the design point. For general understanding, you need the general solution.

However, the ways in which digital computers originally were used essentially denied the description given by my professor. In the past, digital computers were used to carry out exhaustive calculations of many individual cases, which are then "mapped" in some way so as to illuminate behavior over a range of values of a parameter or a variable.

The older idea of mathematics as "computing as little as possible" is now reasserting itself. Powerful and useful as "calculating scratchpads" are, they are still only "front ends" for computer programs of the kind which have been around since the days of the ENIAC. A new class of programs can actually carry out algebraic manipulations and symbolic operations. These operations include solving equations symbolically, and performing symbolic integration and differentiation. Programs of this type include Derive™, Mathematica™, Macsyma™, Maple™, and the latest version of Mathcad (which actually includes a subset of Maple).

Using Derive, for instance, the scientist can type in an equation such as: #1: $a \cdot x^2 + b \cdot x + c = 0$

Then by invoking a "solve" command, Derive produces the following expressions:

$$\#2:\ x = -\frac{0.5 \cdot (\sqrt{(b^2 - 4 \cdot a \cdot c)} + b)}{a}$$

$$\#3:\ x = -\frac{0.5 \cdot (\sqrt{(b^2 - 4 \cdot a \cdot c)} - b)}{a}$$

These solutions are equivalent to the expressions usually presented in algebra books as the solutions to a quadratic equation, and memorized by generations of students.

Symbolic manipulation programs can also factor algebraic expressions. Derive readily factors:

#1: $x^4 + 2 \cdot x^3 - 3 \cdot x^2 - 8 \cdot x - 4$

into:

#2: $(x + 2) \cdot (x - 2) \cdot (x + 1)^2$

Symbolic mathematics programs can be used to solve simultaneous equations. In the rocket example above, we solved two equations simultaneously to obtain the two unknown coefficients in the trajectory equation. However, we would have to solve these equations numerically

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for every different set of launch and peak radius conditions. A general solution would apply to any set of conditions. To get the general solution, we would need to solve the two equations by elimination and substitution, just as algebra students are taught to do. However, Mathematica eliminates the drudge work, carrying out the substitution "behind the scenes." We need only type in the proper series of commands, (denoted below by In), and Mathematica produces the responses (denoted by Out):

```
In[2]:= f1=1/(c*(1+e*Cos [x1]))
Out[2]:=
                    1
        c (1 + e Cos [x1] )
In[3]:= f2=1/ (c*(1+e*Cos [x2]))
Out[3]:=
                    1
        c (1 + e Cos [x2] )
In[4]:= Solve [{f1==1739,f2==apolune} , {c,e}]
Out[4]:=
{{c -> 1 /
   (1739 (1 -  1739 Cos [x1]                    +
               1739 Cos [x1] - apolune Cos [x2]

               apolune Cos [x1]
               1739 Cos [x1] - apolune Cos [x2] )),

e -> -1739 + apolune
     1739 Cos [x1] - apolune Cos [x2] }}
```

Letting the computer do this is certainly much simpler than doing it with pencil and paper. Note that Mathematica used the symbol → in place of the equal sign = in its output.

Substituting in the original values for x1, x2 and apolune, we get:

$\{ \{ c \to 9.97635\ 10^{-7}, e \to 0.599052 \} \}$

which agrees with the numerical solution we obtained earlier. The point is simply that having solved the equation generally, we can then substitute in specific values for a particular solution. Mathematica does all the grunt work of carrying out the substitution and doing the arithmetic.

Symbolic manipulation programs can also perform calculus. The numerical integration of acceleration evaluated in the sounding rocket example above gave only a single number. Suppose, however, we wanted an algebraic expression for the integral. Derive readily integrates:

$$\#2: \int_0^t g \cdot \left[0.5 + \frac{4.5}{30} \cdot z\right] dz$$

to give:

$$\#4: \left[0.075 \cdot g \cdot t^2 + 0.5 \cdot g \cdot t\right]$$

This is a fairly simple problem. We almost don't need Derive for it. However, symbolic manipulation programs are capable of much more. When I was a sophomore calculus student, an "extra credit" problem was the "wineglass problem." The problem was to find the volume of a wineglass, which was taken as an inverted right circular cone. This problem was considered to be so hard that anyone who solved it deserved extra credit (I confess I didn't even try).

With a symbolic manipulation program, however, the problem becomes a great deal simpler. The wineglass is illustrated in Figure 3.

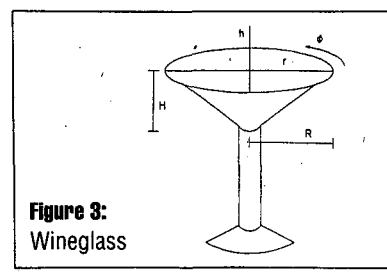

Figure 3: Wineglass

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Height h ranges from 0 to H. Radius r ranges from 0 to R. The angle about the vertical, ϕ, ranges from 0 to 2π. The element of volume then is r dr dϕ dh. The volume is given by:

#5: $$\int_0^H \int_0^{2\cdot\pi} \int_0^{h\cdot R/H} r\ dr\ d\phi\ dh$$

Without even a hiccup, Derive readily simplifies this to:

#7: $$\frac{H\cdot\pi\cdot R^2}{3}$$

which is the known formula from solid geometry.

For one more example of automated calculus, let's integrate the formula for time of flight, used above, only this time integrate it symbolically. Using Mathematica, we can enter: [4]

```
Integrate [1/(( .002) * ( 1+. 599*
    Cos[x])^2) , {x,y,z}]
```

The result is:

$$-1947.65\ \text{ArcTan}\left[0.500781\ \text{Tan}\left[\frac{y}{2}\right]\right] + 1947.65\ \text{ArcTan}\left[0.500781\ \text{Tan}\left[\frac{z}{2}\right]\right] + \frac{799{,}789\ \text{Sin}[y]}{1.66945 + 1.\ \text{Cos}[y]} - \frac{799.789\ \text{Sin}[z]}{1.66945 + 1.\ \text{Cos}[z]}$$

As noted earlier, this is an unpleasant-looking integral, and carrying out the integration with pencil, paper, and a set of tables would be tedious and would run considerable risk of error.[5] Letting the computer do the integration takes much less time, and eliminates human error by the scientist using the program.[6]

These examples show that the dream of the early science fiction writers has been realized. The computer has now been harnessed to the task of manipulating symbols according to the rules of algebra and calculus. Computers are no longer limited to simply crunching numbers.

THE PAYOFF

So computers can both crunch numbers and manipulate symbols. What does this mean to practicing scientists and engineers? Does it make any difference?

It certainly does. Scientists and engineers who have used these new "front end" programs find that they not only increase their scientific productivity, but make possible analyses which simply wouldn't have been considered before.

Hofstadter presents a comparison between these new methods and more conventional methods. His analysis of a heat flow problem required 17 lines of input to MLab, a mathematical modeling program, and the solution, including a graph, was obtained within 15 minutes after starting to enter the input. The customary method of solving the problem by writing a program in FORTRAN, a widely-used scientific programming language, normally takes several hours, including debugging time and the production runs.

Zomeck describes how he uses Mathcad in designing the Advanced X-ray Astrophysics Facility, a satellite which will detect X-rays from hot stars, and provide an improved estimate of the Hubble constant and the age of the Universe. I'll let him speak for himself:

"I use Mathcad . . . almost daily to design and model hardware components, analyze the results of experiments and tests, and design future

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tests and calibrations."

He goes on to say that it is necessary to filter out the ultraviolet light which would also be "seen" by the X-ray detectors. A filter which eliminates the ultraviolet would also stop some of the X-rays, reducing the sensitivity of the experiment. Hence the design of the filters, with the proper tradeoff between unwanted ultraviolet and reduced sensitivity to X-rays, is critical to success of the instrument. He says, "Mathcad allows a quantitative formulation of the problem and the application of 'what-if's' to its solution. Mathcad allows the easy importing of ASCII[7] data and in this application, data relating to the X-ray and ultraviolet absorption by many materials was imported directly." The advantage of directly importing data, of course, is that the data need not be put through a keyboard again. This saves time and effort, and eliminates the possibility of a typing error.

One of the features of the modern scientific laboratory is automated data acquisition. Instead of having someone sit by an experiment and read a gauge or dial every so often, the experimental apparatus is placed under the control of a computer, which collects and stores data either at specified intervals or when triggered by specified events. While this is a convenient way to collect a large amount of data, the data must still be analyzed.

Rydelek and Steiner describe their work with a sensitive gravimeter, which is intended to measure changes in the Earth's gravity field due to tidal effects of the Sun and Moon. Typically they collect several months' worth of data taken at one-second intervals. Their goal is to obtain two-year or three-year records of data, with a new value collected every second. Clearly they could be overwhelmed by their own data if they didn't find a rapid way to analyze it. They report that they and their students use the program MATLAB, which was designed to manipulate large arrays of numbers, to analyze their data as quickly as it is recorded.

Their application is not unique, of course. All the programs discussed above can import data and subject it to analysis according to some pre-defined procedure. Automated data analysis, using these "front end" programs, is the natural complement to automated data acquisition.

Automating the analysis of data in order to keep up with a data stream is one way of dealing with the problem. However, in some cases the objective is to reduce the amount of data collected without reducing the information obtained from the data.

One of my clients presented us with the problem of finding a way to reduce the number of tests they had to run, since each test was very expensive, while still retaining the same level of confidence in the results. Solving their problem required an analysis replete with triple integrals and empirical probability distributions which didn't fit any of the standard distributions. I solved the problem entirely with Mathcad, within a short time. I was able to experiment with several alternative approaches, simply writing these in

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standard mathematical notation, until I could demonstrate that a particular solution procedure made much more efficient use of their test data than did the standard procedure they were using.

However, the client wanted the solution method implemented in FORTRAN, since that was the standard production language in their plant. It took a skilled programmer on our staff nearly as long to translate my recommended solution procedure into FORTRAN as it took me to develop the procedure in the first place. If we had needed to program each tentative solution in FORTRAN before testing it, the time and cost for the project would have been prohibitive. Without a program like Mathcad the problem couldn't have been solved at reasonable time and cost.

Of course, solving a problem quickly is often only half the battle. The result must still be written up as a report or journal article. In the past, when the results of an analysis came out of a mainframe computer, they often had to be retyped to be included in a report, with all the delay and risk of error that goes with retyping something. That too has been changed by the programs described above. All the programs which run on either the Macintosh™ or under DOS-Windows™ now incorporate what are called "notebooks." These notebooks allow the scientist to incorporate text, "active" mathematics, and graphics, just like the familiar lab notebook which scientists have been using for decades. Thus the scientist can organize the analysis as the work proceeds, with everything necessary for publication being included "on the fly."

Figure 4 is an illustration of such a "notebook page." It presents an analysis of a simple electrical circuit. When the switch is closed, current flows from the battery through the resistor into the capacitor. Current flow ceases when the capacitor is charged up to the voltage of the battery. The drawing of the circuit was made in a CAD (Computer Aided Design) program, then imported into Mathcad directly from that program. The definitions were inserted into the notebook as text. The equations were written as "active mathematics," and carry out the actual computations. Note that the "rkfixed" function carries out a Runge-Kutta 4-th order integration with fixed step size. This is just one more example of the capabilities of programs such as Mathcad. The final results are graphed at the bottom of the page. This of course is a trivial example, but it illustrates what can be done. Programs such as Mathcad not only speed up the process of analyzing data, they simplify the process of reporting the results.

The effect of these programs on scientists and engineers, then, is to multiply their productivity enormously. These programs do this by placing very powerful mathematical tools right on the researcher's desk. The researcher can use them to solve equations, manipulate symbolic expressions, substitute numerical values into symbolic expressions, and employ a wide range of mathematical techniques such as Fourier analysis, all

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Analysis of Resistor-Capacitor Circuit

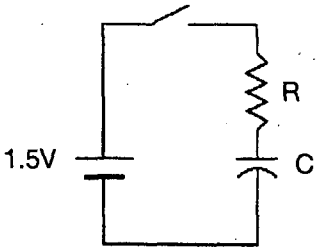
C - capacitor
R - resistor
q - charge on capacitor
v - voltage on capacitor = q/C

$q_0 := 0$ coulomb

R := 100 ohm

C := .1 · farad

V := 1.5 volt



$$D(t,q) := \frac{V - \frac{q}{C}}{R}$$

Z := rkfixed(q, 0, 100, 100, D) t := 0..100

$$Cap_Voltage := \frac{(Z^{<1>})}{C}$$

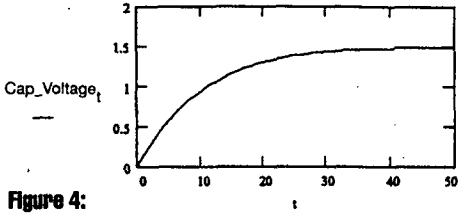


Figure 4:
Example of Notebook Page.

without doing any programming, or requiring the assistance of a programmer. The results can then be put directly into reports or journal articles, incorporating text, formulas and equations, and graphics.

SOME CAVEATS

Is there a down side to these new tools for the researcher? Yes. These new software packages, like any other tool, can be dangerous in the hands of those who use them incorrectly, or who don't understand their limitations.

Phillips and Leslie report an attempt to calculate the minimum possible pollution from a combustion process, taking into account the fact that at chemical equilibrium, some of the water and carbon dioxide produced by the combustion will dissociate and recombine to form hydrocarbons and oxygen. They report that they attempted to calculate the equilibrium constant for this reverse reaction, using Mathcad as well as several other software packages. All the software packages they tried failed in the task. The problem was that these packages didn't carry the numbers out to enough decimal places. The computation involves division by a very small number, and

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the programs effectively replaced the small number by zero, because it was smaller than the smallest number they could represent. Because of this difficulty, the researchers had to devise an alternative approach to solving the problem, writing their own program in a popular programming language.[8]

The problem of inadequate precision is not a new one, of course. As an engineering student in the 1950s, learning to solve problems on a slide rule, I was thoroughly warned about the dangers of "small differences between large numbers." A slide rule could carry numbers out to only three or four significant figures. Computer programs today can do more significant figures than that, but they only push the problem out to the right of the decimal point somewhat. The problem doesn't go away completely.

This example simply shows once more that failure to understand what the software is doing can lead the researcher to a false conclusion. Fortunately for the combustion researchers who reported the problem, the failure was obvious. Had they obtained an answer which "looked reasonable," they might not have known it was badly in error.

As another example, consider the Runge-Kutta procedure used in the electric circuit example above. This uses a fixed step size for carrying out the computation. As it happens, that is the correct approach for the particular problem of the example. However, for other types of problems it might not be correct. Other problems might require a variable step size, to compensate for radical variations in the behavior of the function being integrated. The researcher must choose the proper mathematical procedure, and that requires knowing the strengths and limitations of the procedures which might be applied to a problem.

In short, these software packages greatly simplify the work of the scientist or engineer. However, they are not a substitute for understanding the problem and the nature of the various solution techniques. Like any powerful tool, these packages are dangerous when used improperly. The researcher who uses one of these packages blindly runs a very real risk of getting wrong answers without realizing it.

Even recognizing the dangers, however, these powerful new tools are already making a big difference in how scientists work, and they will make even bigger differences as they become more powerful, and are more widely used. The science fiction writers of the 1930s had it right, but it took a long time to bring their dream to fruition.

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[1]This is net of Earth's gravity. Equipment aboard will be subjected to three *g*'s acceleration.

[2]Mathcad uses certain keyboard symbols which are not used in mathematics, such as "&," to represent standard mathematical notation.

[3]Of course we know a third point as well, the landing point. However, because of the symmetry of the ellipse, the radius is identical at both launch and landing on a spherical planet, hence this third point provides no independent information.

[4]Note that for input, Mathematica utilizes a "command line" entry format, instead of the more natural mathematical notation format used by Mathcad and Derive.

[5]It's worth noting that after Mathematica came on the market, users discovered several errors in published tables of integrals. These had never been discovered before because no one wanted to go to the task of repeating the intellectual coolie labor which went into producing them in the first place.

[6]Of course there may be errors built into the program. An early version of Mathematica, for instance, had a "bug" which resulted in an erroneous value for the Normal probability distribution. These bugs are fixed as soon as they are identified, but there can be no guarantee that there are none left in the various programs.

[7]ASCII stands for American Standard Code for Information Interchange. It is an internationally used standard for exchanging data from one computer program to another.

[8]Mathematica, which allows any degree of precision up to the limits of the computer's memory, probably could have solved the problem as the authors initially approached it. ■

If hard work were such a wonderful thing, surely the rich would have kept it to themselves.

—Joseph Lane Kirkland

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Probability Zero

Michael A. Burstein

SENTIMENTAL VALUE

I barged into Stan's office, pushing off Ian and Scott as they tried to hold me back. As I slammed the door behind me, I heard muffled shouts of "Stan, watch out!" coming from the two of them.

Stan looked up. He was sitting at his desk, a pile of slush perched precariously on top, all the way up to his chin. He blinked, rubbed his head, tugged at his beard, and smiled. His eyes twinkled.

"Michael!" Stan got up, allowing the manuscripts to fall over and onto the floor; it turned out that his chin had been holding them in place. He walked over to me and shook my hand warmly. "It's a pleasure to see you. Glad you finally made that first sale, eh? Wish I could've been there when you heard the news. I've always wanted to see the joy in my writers' faces when they find out."

I stared at him for a second, goggle-eyed. Of course, he didn't realize yet that the jig was up. "Knock it off, Stan!" I exclaimed. "I know as well as you do that you practically *were* there."

Stan pulled back from me, a nervous look on his face. His brow began to sweat. He pulled a white silk handkerchief from his pocket and mopped his forehead furiously. "What do you mean?" he whispered.

"I know all about the camera. I want to see my picture."

Stan put away the handkerchief and retreated behind his desk. "What camera?" he asked.

Now *I* smiled. "The camera that Sydney told me about. You remember, you ran into her at a convention. A fellow Clarionite. She told me about the magic camera you use to photograph new writers when they make their first sale to you. I want to see my picture."

"Shhh!" Stan looked around, nervously. "Don't use that word!"

"What word? Picture?"

"No!" He looked around again, leaned close to my ear, and whispered, "*Magic.* As the editor of *Analog,* the bastion of hard science fiction, I could lose my credibility if it was found that I was using magic to serve my ends, and not good old hard-science-with-rivets. And if *I* lost my credibility, so," he intoned solemnly, "would the magazine."

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I shuddered; if that happened, I knew that my career as a hard science fiction writer would be over as quickly as it began. All the other writers would point at me and say, "Ha ha! You don't really write hard SF! Not even soft SF! Your editor uses magic!" I would be forced to turn to fantasy for a living, and as I noted once when a story of mine was trashed in a workshop, for me fantasy is a lot harder to write than science fiction. The only way I'd survive would be by writing ten-volume trilogies about cute elves, since that was all I could handle in the genre. Surely a fate worse than death, or even chairing a Worldcon.

"Your point is well taken," I replied quietly. "I will not spread the word about the camera, not even until the stars grow old and our Sun grows cold. However," I continued, "I still want to see my picture."

Stan nodded and pushed a button on his desk. A dark hole with fuzzy boundaries opened up in mid-air, obviously a product of advanced science or—well, let's just invoke Clarke's Third Law and leave it at that. Stan reached in and pulled out an old style accordion camera, along with a thick manila envelope.

"It works by pushing this button," he said, "and then a photograph magically—I mean, scientifically—appears out of this slot. Similar to a Polaroid. The camera reaches through time and space and finds the correct rays of light to imprint onto the photograph. But it only works if I click the button *after* the writer has found out. One can't predict the future, you know, that would be a violation of—"

I took the envelope from Stan as he began to spout equations of general relativity and quantum field theory. There was a whole slew of pictures, in chronological order. I recognized some of the other authors, excited looks on their faces, appearing younger than I remembered. That made sense, naturally, because they were younger when they made their first sales. Out of curiosity, I pulled out Ian's picture; his maniacal grin was unmistakable.

Finally, I reached my picture. There I was, jumping into the air, with the telephone in my hand and a big smile on my face. The perfect souvenir of my first sale; after all, I couldn't have the check and cash it, too.

"I want the photograph," I said.

Stan stopped his lecture and pulled the picture out of my hands. Frowning, he said, "I can't give it to you, Michael. I keep them for myself. It reminds me of why I went into editing in the first place."

"Just this one, Stan? You won't miss it, and it means a lot to me." It did, too; my fiancée wasn't around when I heard the news, and this would be the best way to share the moment with her.

"Well . . . " Stan said, "you'll have to give me something in return."

"I don't have much money. I'm only a writer."

Stan laughed. "Oh, I wasn't thinking of money! Actually, all I'd want in return is another story from you. We've got a hole in the magazine for next month, and I need to fill it with something. The picture could be your payment."

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My ears perked up. In exchange for the picture, Stan was going to publish *another* story of mine? "Sure! What kind of story would you like?"

"Could you give me a 'Probability Zero'? It's only a small hole, and anyway, you can make one of those short enough to be the right price."

I was confused. "What do you mean? The right price? What do you consider to be the right price for the photograph?"

"Oh," he said, with his ubiquitous smile and twinkle in his eyes, "I figure the picture is worth . . . about a thousand words."

I hit him with a Hugo rocket on my way out. It felt good. ■

Photo by Jane Jewell

Kneeling, left to right: Michael F. Flynn, Bob Eggleton. Standing: Tina Lee, Stanley Schmidt, Joachim P. Rosler, Bud Webster.

The Analytical Laboratory awards for 1994 were presented at a special reception held in the Bertelsmann Building on April 21, 1995, as part of the Nebula Awards weekend in New York City. Winners present were Michael F. Flynn, whose "Melodies of the Heart" won the award for best novella/novelette; Bud Webster, whose "Bubba Pritchert and the Space Aliens" won for best short story; and Bob Eggleton, whose March cover for "Waterworld" was voted the year's best. G. Harry Stine, who won the best science fact article award for "The Rooster Crows at White Sands," was unable to attend.

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James Gunn

THE LENS OF TIME

Vision requires more than good optics. . . .

Illustration by Janet Aulisio Danheiser

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Where they beheld only a drop of rain slowly rolling down the window-glass, I saw a universe of beings animated with all the passions common to physical life, and convulsing their minute sphere with struggles as fierce and protracted as those of men.

Broadway swarmed with life like water in a stagnant pond. Scarlet and yellow omnibuses raced through the open parts of the street and locked wheels where it was narrower. At irregular intervals they stopped to discharge passengers. When the passengers stretched their hands through a hole in the roof to pay the conductor his ransom for release, he pulled a cord that opened the door and deposited them in a sea of slippery mud, to run a gauntlet of cart wheels and horses' hooves, before they could reach the relative safety of the pavement next to the buildings. Loaded stages stopped in front of hotels such as the Astor House or the St. Nicholas. Railway cars holding as many as thirty persons and drawn by two or even four horses came down the side streets. All these among the carriages, the commercial wagons, and the foot traffic contributed to the clutter and the crush. Next to the buildings or leaning over into the gutters were boxes, buckets, lidless flour barrels, baskets, decayed tea chests, rusty iron pans, and earthenware jars full of ashes and vegetable refuse. All contributed their share of foul odors to that of the horse dung steaming in the ankle-deep mire of the street.

The man in the black cloak stood at the corner of 8th street and Broadway looking at the turmoil around him with the observant gaze of a scientist, absorbing the scene as a panorama before isolating the individual parts and analyzing them. What passed him was a polyglot mix of workmen and gentry, settled citizens and confused immigrants with their bundles of clothing hung over their backs. Some spoke American English, but many conversed in German and others in English transformed in Ireland into music.

In all that confusion of traffic and appearance and dress, no one paid any attention to the man in the black cloak. He picked his way down Broadway, staying close to the buildings to avoid being splashed by the onrushing vehicles and horses, and worked his way around heaps of refuse, until he reached Jones street. His eyes focused on a sign attached to a building on the west side. The sign read "Pfaff's" and stairs led down to a cellar entrance.

As the man in the black cloak opened the door his ears were assailed by the confused clamor of laughter and multilingual conversation, clattering dishes and clinking glasses, and voices shouting, and he breathed in the heady odor of lager beer and rich German food. The room was filled with wooden tables and chairs that extended to a modest bar against the wall, flanked by a swinging door leading to a kitchen. As the man in the black cloak stepped into the room, he could see that the room extended into an alcove under the sidewalk. There, at a huge table set with dishes and glasses, some twenty

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young men and a couple of women were talking with great animation. All but one were fashionably dressed.

The man in the black cloak seated himself at an unoccupied table nearby and ordered a glass of wine before he turned to watching the table of revelers in the alcove. Occasionally he could overhear a scrap of conversation or song, but mostly the competition for attention created only a hubbub of noise. From time to time someone left, lingeringly, as if tearing himself from loved ones, and sometimes one or more persons arrived to a chorus of welcomes and clasps of fellowship.

Finally a man arose unsteadily from near the head of the table, and with many long farewells, made his way toward the door. He had a young face, although at the moment it was flushed and the eyes were a bit glazed. He had a broad forehead from which his long brown hair had already started to recede, a substantial nose that had been broken at least once, and a receding chin that he partially concealed by a bushy, swooping mustache. As he passed, the man in the black cloak arose from his chair and said, "Mr. O'Brien?"

"You have my name, sir," the other said, a touch of Ireland in his voice. "But you have the advantage of me."

"You are Fitz-James O'Brien, the noted poet, playwright, and author?" the man in the cloak continued.

"The same," O'Brien replied with a hint of impatience.

"Let me apologize for accosting you thus," the man in the cloak said, "but my name is T. J. Whelpley. I am a physician, and a writer, though not by any means of your stature and renown, and I have been waiting to speak to you on a matter of some urgency."

"And what would that be, Dr. Whelpley?"

"Will you come to my rooms, Mr. O'Brien, so that I can show you something interesting and we can talk at leisure?"

"Do you have any beer?" O'Brien asked.

"I have some reasonably good claret."

"Claret will do," O'Brien said. "I was going to my room to work on a new poem, but, to tell the truth, it was only duty that called me and not Calliope or Erato. Lead on, my dear Dr. Whelpley."

In the common spots of mould, which my mother, good housekeeper that she was, fiercely scooped away from her jam pots, there abode for me, under the name of mildew, enchanted gardens, filled with dells and avenues of the densest foliage and most astonishing verdure, while from the fantastic boughs of these microscopic forests hung strange fruits glittering with green, and silver, and gold.

They emerged into the night of Broadway, lit now by gas jets and scarcely less busy than by day. Indeed, it was crowded even more by the parade of a uniformed company of the New York Seventh Regiment.

"The latest census counts more than 600,000 residents of this small island," O'Brien said, "and it has al-

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most doubled in the past decade. Where will we put the people and the horses and the vehicles when there are a million?"

"They will come sooner than you think," Whelpley said. "But there is much room for growth north of Forty-second street. Steam soon will replace horses, and who knows, the new Central Park may one day be aptly named."

A clanging sound down the street was followed by the appearance of a fire engine dragged along by a crew of more than twenty men followed by a mob of shouting and cheering boys. The volunteers wore large boots, dark pantaloons held up by leather belts, thick red shirts, and firemen's helmets.

"Many famous people of the literary and theater world were gathered at your table," Whelpley said.

O'Brien laughed. "The Bohemians. A hearty, hard-drinking lot. But redeemed by genius. Or so we tell ourselves."

"Was that Mr. Whitman, the poet, sitting on the other side of the table? The one with the open-necked shirt and the flowing hair?"

"You mean the editor of the *Brooklyn Daily Eagle*?"

"His *Leaves of Grass* came out two years ago."

"And a queer, unrhymed thing it was, too. Hardly any meter either. Yet it has a strange power," O'Brien mused. "Perhaps I will try this free verse myself one day."

"Have you ever considered," Whelpley asked, "the power you wield over the soul of this developing city and nation?"

O'Brien laughed again, boisterously. "We Bohemians? You give us too much credit. We are poor scribbling fools trying to scratch out a living by our wits and our influence is as ephemeral as the paper on which our words are printed."

The two men were silent as they made their way along the paved pedestrian walk, a few inches above Broadway's mire. Whelpley moved purposely, O'Brien, a bit unsteadily. Ragged women, some not twelve years old, tugged at their clothing and tried to look desirable.

"Get along with you, girls," O'Brien said gruffly. He turned to Whelpley. "Is it far? I'm getting thirsty."

"We're almost there," Whelpley said. They had been passing business buildings with ornate stone or cast-iron fronts, but now a row of decaying mansions was on their left, massive staircases leading to small porches. "Here," Whelpley said.

O'Brien looked up at the building. "Like me, you live in a boarding house. Where will we put those million people, do you think?"

"Housing will be built, some kinds of apartments, I would guess."

Whelpley led the way, unlocking the front door, and entering a once stately hall, now stained and marred by time. To the left was what had once been a sitting room, with a cheerful fireplace and a scattering of chairs and tables. To the right was a dining room with a big table surrounded by chairs. This part of the house, at least, had been kept up, although the hall smelled of boiled po-

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tatoes and onions and fried meat. Ahead was a broad staircase leading to an upper floor. Up that staircase Whelpley led O'Brien and then, ignoring the smaller staircase leading to the upper floors, he turned right and unlocked a door.

Inside was not simply the single room of most boarding houses but several rooms. Whelpley lit a gas jet to reveal the first of them, a physician's office with desk and chairs and bookcases, examining table and glass cases filled with instruments and bottles filled with pharmaceuticals, and charts of the human anatomy upon the walls. Beyond, to the right, O'Brien glimpsed what seemed a bedroom; to the left, as Whelpley lit the gas there as well, O'Brien could see a third room fitted out as a kind of laboratory. Racks of chemicals filled the walls and experimental tables, equipped with retorts and tubes and bottles of fluid, were arranged neatly about the bare floor.

"You are a scientist as well as a physician," O'Brien observed. "Now about that claret. . . ."

Whelpley motioned O'Brien into the laboratory. Indicating a stool in front of a bench on which stood some kind of instrument draped with an off-white canvas cover, Whelpley left the room and a few moments later returned, absent his cloak, with a decanter half full of reddish liquid and a couple of tumblers. "Forgive the absence of amenities," he said. "I don't entertain in my rooms." He poured both tumblers half full.

"Nor do any of us unlanded gentry." O'Brien picked up the glass and sipped it as if judging its age and character. "That is good stuff," he said, "as good as ever I had in London or Paris." He drained it in a couple of swallows and held out his glass for a refill.

"First let me show you what I brought you here to see," Whelpley said. He lifted the cover from the instrument on the table in front of O'Brien. It was a microscope, almost a work of art with a slender brass barrel extending above brass feet, an exquisitely machined knob on the side, and a silvered mirror below. Whelpley lit a small gas jet on the table, took up an eyedropper full of water from a nearby jar, squeezed a drop onto a glass slide, and slipped it into arms just above the mirror. Looking through the eyepiece, he adjusted the mirror and the knob to bring the slide into focus. "Now," he said, lifting his head and gesturing for O'Brien to take his place.

O'Brien hesitated and then, shrugging, peered into the eyepiece. He raised his head. "I don't see a thing."

"Take a moment for your eye to adjust," Whelpley said. "Just relax. Don't try to make something happen."

O'Brien sighed and looked again through the eyepiece. After a moment he twitched and said, "Fascinating!"

"What do you see?"

"Lots of little creatures moving around as if in another world. What is it?"

"That's a drop of water I got from a nearby well. And those little creatures, or animalcules, are part of the

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process of life. We drink them. They live within us or they die. They may even make us ill. They share our world, but they—and we—know nothing of the other. Until now."

Like all active microscopists, I gave my imagination full play. Indeed, it is a common complaint against many such, that they supply the defects of their instruments with the creations of their brains. I imagined depths in Nature which the limited power of my lenses prohibited me from exploring. I lay awake at night constructing imaginary microscopes of immeasurable power, with which I seemed to pierce through all the envelopes of matter down to its original atom.

O'Brien looked at the microscope with greater respect. It was not only an artificer's work of art, it had the unsuspected power of revealing the unknown, perhaps the unknowable. "I've heard of the microscope, of course, but I had no idea—. What kind of microscope is it?"

"It's called a Spencer Trunion," Whelpley said. "But that's not important."

"To a writer everything is important." O'Brien was excited now. He had forgotten about the claret. Once more he peered into the eyepiece and studied the slide. "Incredible!" he muttered.

"What is incredible is what it means."

"Of course. What a fine story it would make."

"Perhaps you can use it for one of your 'Man About Town' columns for *Harper's*."

"It's too good an idea to waste on a column. No, it should be a story in its own right. Someone looks through a microscope, maybe a really big one, and sees—what? Something wonderful!"

Whelpley half-filled O'Brien's glass but O'Brien ignored it. "Perhaps we should talk in the other room where there are chairs."

The physician picked up both glasses and moved into the examination room. He put the glasses on the desk, took his seat behind it, and motioned O'Brien into the chair in front.

"You want me to write about the unsuspected creatures that lurk around us, that we breathe in and we drink, that may make us ill," O'Brien said.

Whelpley shook his head. "They may indeed injure us. A German physiologist has already speculated about the microscopic basis of life itself, and biology is destined to become the queen of the sciences. But what I am concerned about is even more basic than that, and that is the growing conflict between reason and emotion."

"What if a microscopist should actually see another world?" O'Brien said. "It would have to be a different kind of microscope, of course, or someone would have seen it before."

"People will make better microscopes," Whelpley said, "just as they improve on everything. McCormick's reaper has been around a quarter of a century, the telegraph for two decades, nitroglycerin for a dozen years. Invention is changing our lives. Why,

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I hear that someone had invented an elevator, which means that the height of buildings in Manhattan no longer will be limited by the distance people can climb stairs."

"How could a better microscope be built?" O'Brien said. "More lenses? Different materials? Is there something exotic one could make a lens out of? A diamond, perhaps?"

"Actually a diamond was used for a lens sometime in the 1820s with no improvement in resolution," Whelpley said. "What I want to talk to you about, however, is the way science is changing our lives. A couple of European political philosophers commented on the process a decade ago." He removed a book from the shelves behind his desk, flipped it open, and began to read from it. " 'The bourgeoisie during the rule of scarce 100 years has created more massive and more colossal productive forces than have all preceding generations together. Subjection of nature's forces to man, machinery, application of chemistry to industry and agriculture, steam navigation, railways, electric telegraphs, clearing of whole continents for cultivation, canalization of rivers, whole populations conjured out of the ground—what earlier century had even a presentiment that such productive forces slumbered in the lap of social labor.' "

"Maybe one could use this new all-purpose stuff, this electricity, in combination with a lens made out of diamond," O'Brien went on.

"Look at what the railroad has done to this country, already, linking distant places," Whelpley said. "Why, there's a state in the southwest as big as five New Yorks, and one clear on the other coast less than a decade old, with fields of gold sufficient to satisfy everyone's greed. And in another decade we may be able to travel to both of those states by railroad. Distance will be annihilated. And one day we'll fill up all that empty space with people."

"But how would some innocent experimenter find out about such a process?" O'Brien mused.

"Look at what has happened in electricity," Whelpley said. "Every decade, beginning in 1800, has come a new development: the storage battery, the electric motor, the electric generator. . . . What will come next? Electric lights? The harnessing of sound, voice communication over long distances?"

"Perhaps a medium might put him in touch with some long-dead microscopist," O'Brien said.

"And basic science. Like the nature of matter or chemical combination, or the origin of life. There's a French scientist trying to figure out why wine turns sour. Who knows what may come of that?"

"I could write a story about someone building a fantastic microscope using a lens made of diamond," O'Brien said.

"What the world needs," Whelpley said, "is a better understanding of science and how it is changing the world for the better. Or the worse. Of course invention has been applied to warfare as well—rifle bullets for instance, and the firearm magazine, and the revolver. Ways to kill more peo-

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ple faster."

"But where would he get a diamond big enough to use as a lens?" O'Brien said.

She swept out from between the rainbow-curtains of the cloud-trees into the broad sea of light that lay beyond. Her motions were those of some graceful Naiad, cleaving, by a mere effort of her will, the clear, unruffled waters that fill the chambers of the sea. She floated forth with the serene grace of a frail bubble ascending through the still atmosphere of a June day. The perfect roundness of her limbs formed suave and enchanting curves. It was like listening to the most spiritual symphony of Beethoven the divine, to watch the harmonious flow of lines.

"Look at that," Whelpley said, gesturing at a drawing hanging on the far wall. O'Brien turned to look at it. The drawing displayed the human body, with the skin removed to reveal the muscles and the internal organs. "The part that distinguishes us from the animals, the brain, is so small compared to our oversized genitals. Our lusts, our emotions, are more important to us than our rational processes."

"My microscopist would have to fall in love with something," O'Brien said. "Maybe a beautiful female creature living in a world far beyond his reach, beyond even the ability to hear or understand his hopeless passion."

"People fear thought when they ought to fear uncontrolled emotion," Whelpley said. "You and your friends, these men of genius, could help explain and dramatize the issues, the prospects for the future, could give readers a sense of what the future will bring and how their own humanity may be enhanced by it."

"Of course it would be futile," O'Brien said.

"Because if we don't do something, the passions accumulating in the world will find expression that may shatter every hope. Revolution is epidemic in Europe, and in this country events move us toward civil war."

"War? Here?" O'Brien said. At last Whelpley had claimed his attention.

Whelpley reached into the shelf behind him and removed a book that he pushed across the desk toward O'Brien. "Have you read this?"

O'Brien picked up the book and looked at its title. "Dear Sentimental Mistress Stowe," he said ironically. "One doesn't read a book like this, one browses through it."

"Thousands of people have read it, and it has inflamed their imaginations. I believe in the abolition of slavery and the freeing of the slaves, but rationally—not through bloodshed and anger."

"Surely it will not come to that," O'Brien said.

"Perhaps not for slavery alone, but for political reasons dividing the northern and southern states. The fighting in Kansas is only the prelude to a larger battle. Already a senatorial candidate in Illinois has told his state convention that 'a house divided against itself cannot stand.' If someone like that gets elected president, what do you think the southern states will do?"

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"Why, they will work like hell at the next election, of course," O'Brien said.

"If they behaved rationally," Whelpley said. "But fear and hatred are powerful emotions, and I foresee great tragedies ahead unless thinking men and women work together to quench the flames of passion with the cool waters of reason."

"A sort of volunteer fire-fighting company of the mind, eh, Dr. Whelpley?" O'Brien said.

"You joke," Whelpley said. "Yet I am perfectly serious. A war between the states would shatter this nation for generations and create hatreds that would last for a century. If war should start after the next presidential election, you yourself would be one of the first to volunteer, and being the romantic Irish gentleman that you are, you would seek the heat of the battle and be killed within the first year along with hundreds of thousands of young men north and south."

"You may be right," O'Brien said. He did not seem disturbed at the prospect. "To die in the service of one's adopted country would not be so terrible a fate." He reflected upon the matter for a moment. "It would, at least, settle my debts once and for all. My microscopist would have to die, of course. Or perhaps go mad."

"If you insist on writing a story about a microscopist," Whelpley said, "then make him a scientist, discovering the causes of disease, perhaps ministering to dying soldiers and discovering the causes and treatments of putrefaction."

O'Brien smiled knowingly. "You may understand microscopes, but you don't understand human nature. To make a perfect microscope is an act of hubris, and it must be punished by Nemesis."

"It's you, my dear O'Brien, who do not understand science. To explore more deeply is not an act of hubris but a use of those faculties that distinguish mankind from the brutes, and to discover the ways in which the Universe works is to free oneself from Nature's tyranny rather than to invoke the wrath of the Gods. And that is the vision I would hope you would help make available broadly before it is too late."

"It wouldn't work," O'Brien said, lifting his glass and draining its contents. He looked longingly at the decanter and then rose to his feet, no longer unsteady. "I don't have the power. None of us has the power. And not a person is changed by poetry or literature except those who don't need changing. The people you want to reach don't read *Harper's* or *The Atlantic*. But I want to thank you for a good claret, a stimulating conversation, and a wonderful idea for a story which, if I deal with it properly, may make my reputation—or at least a hundred dollars.

"And so good night to you, Dr. Whelpley. If I may, I would like to call upon your expertise again to assist me with the details of my story which I think I shall call 'The Diamond Lens.' "

O'Brien bowed and made his way to the door and down the broad stairs into the night while Whelpley stared, his glass forgotten in his hand, at the drawing of the flayed human body on the far wall. ■

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"TEXAS" IN MUNICH, PART 2: GAMMA RAY BURSTS

This is the second of two columns reporting on the 17th Texas Symposium on Relativistic Astrophysics held on December 12-15, 1994, in Munich, Germany, where I am presently on sabbatical. The "Texas" in the title refers to the site of the first of these meetings, which was held in 1962 in Dallas, Texas, shortly after the discovery of quasars. Munich was host to the most recent Texas Symposium because, through its Max Planck Institutes for Astrophysics and for Extraterrestrial Physics, it has become a center of work in x-ray astrophysics, both theoretical and observational, as well as the home base of the European Southern Observatory. In this column I will give an overview of what I consider to be the most puzzling phenomenon discussed at the Symposium: gamma ray bursts.

* * *

• *The CIA Discovers Gamma Rays from Outer Space!*—in 1967, during the Johnson Administration, the United States became a party to an international treaty that banned the testing of nuclear weapons in space. In order to verify that the terms of the treaty were being observed, in the late 1960s the CIA and other intelligence agencies arranged for the Air Force to launch the VELA series of surveillance satellites, which carried omni-directional detectors sensitive to pulses of gamma rays that would have been emitted in great numbers by any space-based tests of nuclear weapons.

And indeed, starting soon after the first VELA probe was activated, bursts of gamma rays were detected every few days. Could there be so many weapons tests in space? The intelligence analysts were baffled and suspected satellite malfunctions or some

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form of deliberate jamming that would hide real tests. Finally, with several satellites in orbit simultaneously it became possible to use the arrival time of the pulses at different locations to determine the direction of the source of the radiation. It was found that the bursts always came from directions that pointed outside the Solar System. The existence of these bursts was kept as a closely guarded secret for several years. As it turned out, the VELA satellites never detected a single nuclear explosion, (or at least none originating in our Solar System). However, if this surveillance in space had not led to this accidental discovery, it is doubtful if even today we would be aware of the phenomenon.

Finally in 1973, some years after the initial discovery, a paper was published in *Astrophysics Journal Letters* describing the observation of gamma ray bursts. The astrophysicists of the world were confronted with an unexpected new phenomenon. Over 20 years later, at the time of the 17th Texas Symposium of Relativistic Astrophysics, there is still no adequate explanation for the gamma ray burst (GRB) phenomenon.

• *The gamma ray bursts at the Texas Symposium*—BATSE is an experiment on NASA's Compton Gamma Ray Observatory satellite specifically designed to study the GRB phenomenon. At the 17th Texas Symposium Dr. Gerald Fishman, the leader of the BATSE project, gave an invited talk that provided a nice overview of the detector and its results.

Also increasing rapidly are scientific papers on the subject of GRB. Fishman counted about 2,000 GRB papers. A recent review article has also provided a list of over 100 theoretical models, all of which in different (and usually mutually exclusive) ways attempt to explain the GRB phenomenon. On the afternoon following Fishman's talk there was a special session of papers devoted to the gamma ray burst phenomenon and recent analysis of data, some of which I will summarize here.

Gamma ray bursts have a very unusual set of features that have proved very difficult to explain. Here are some of them:

(1) Duration—The most enigmatic characteristic of the gamma ray bursts are their very short time duration. The burst duration can be as short as $^1/_{1000}$ of a second, but bursts that continue for a few minutes have been observed, and continued GRB activity in a few cases has been recorded for an hour or more. In astrophysics the minimum time variation of a phenomenon, when multiplied by the speed-of-light, is taken as an indication of its intrinsic size. The millisecond time constant of GRB thus suggests a source about 300 kilometers in diameter. For those who would explain the GRB phenomenon, this is an uncomfortably small size even for compact astronomical objects like neutron stars and black holes.

(2) Rate of Occurrence—At the time of the Texas Symposium, after about three years of operation, the BATSE experiment has recorded over 1121 GRB events at a rate of about

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one per day. Due to Earth-shadowing and other effects BATSE has a detection efficiency of about 33%, so the true rate of GRB occurrence is about 3 per day or 1,000 per year. GRB are very frequent indeed.

(3) Distribution of Locations—the GRB events recorded by the BATSE experiment show a uniform distribution in the sky, with no preference for the plane of the Solar System, the plane of the Galaxy, or for any particular direction. Further, there is no evidence of a clustering of bursts or of repeating locations. As far as one can tell from the present data, every GRB event is new and unique. The GRB's uniform distribution of locations is now accepted by most astrophysicists as an indication that the phenomenon is "cosmological" in origin, i.e., that GRB do not originate in our Solar System or Galaxy but come from extragalactic sites that are very far away.

(4) Energy Content—Typically during the detection of a GRB event each square centimeter of detector area receives about 10^{-5} ergs (or 6.25 MeV) of energy. If we know (or guess) the distance to the source of the GRB, this detected energy value can be used with the inverse square to calculate the energy released by the source. If the GRB source emitting gamma rays uniformly in all directions were in the outer halo of our Galaxy at a distance of 100 kilo-parsecs, its net energy release would be 10^{41} ergs (or about 11 times the mass of Mars's largest moon Phobos converted completely into energy). If the uniform GRB source was cosmological with a distance of about 3 giga-parsecs, its net energy release would be 10^{51} ergs (or almost the mass of Jupiter converted completely into energy). If the source were to "beam" the gamma rays like a lighthouse, these needed energies might decrease by a factor of 10 to 100.

(5) Energies of Gamma Rays—Typically the energy distribution of gamma rays in a GRB peaks at around 200 KeV (thousand electron-volts) and extends well into the MeV (million electron-volts) region. This spectrum has the wrong shape to be produced by a very hot thermal object. The distribution of the Gamma rays with energies of up to 25 GeV (billion electron-volts) have been observed. These high energy gammas usually occur much later than the main burst, following by several hundreds seconds or more.

(6) Time Structure—The time profile of GRB varies enormously from burst to burst and over time scales from milli-seconds to minutes. Examples of time structures that are smooth, multi-spiked, short, long, complex, and quasi-periodic can be found among the catalog of GRB. One common time profile is the "FRED," an acronym that stands for fast-rise and exponential decay. There is, however, no evidence for any regular periodic time structures like those that might be expected from a rapidly rotating neutron star or merging pair of neutron stars (see below).

(7) Counterparts of GRB—Ever since their discovery, and particularly since BATSE has gone into operation, there have been many attempts to correlate the occurrence of GRB with excursions in the output of objects

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observed with radio telescopes, infrared telescopes, optical telescopes, cosmic ray detector arrays, and even neutrino detectors. So far, there is no convincing evidence of any counterparts of GRB. For those GRB that are the best localized, there is also no particular correlation with stars or galaxies in the same angular "detection box."

(8) Intensity cutoff of GRB—The BATSE detector has sensitivity to GRB that are considerably weaker than the "average" GRB detected. Analysis of the observed GRB shows that there are considerably fewer weak GRB than would be expected if these were distributed uniformly in space and time. This suggests an "evolution" of the phenomenon, in other words, that in earlier stages of the Universe there were fewer GRB events than there are now.

• *GRB Theories*—At the Texas Symposium there was also considerable discussion of theoretical models of gamma ray bursts. There are three generic sites where theories have attempted to place GRB sources: in the Oort cloud of our Solar System, in the halo of our Galaxy, and at cosmological distances. The Oort cloud models are attractive because they require a much smaller energy release to explain the observations. However, they have been largely excluded by the BATSE measurement of uniform location distributions and by timing measurements that place the GRB source at a distance of at least 25 AU (Earth-Sun radii) away.

There are still some advocates who would place the GRB in the halo of our Galaxy, attributing GRB to phenomena like comets falling on neutron stars or events involving very magnetic neutron stars. These models also have problems with the BATSE measurement of uniform location distributions, and would require very energetic ejection of neutron stars from the galactic plane when they are formed in supernovas.

The "standard model" for explaining GRB would place them at cosmological distances and attribute them to the merger of a binary pair of neutron stars that are spinning down to collision as they lose energy through gravitational radiation. Such objects are known to exist and have been carefully studied. It is estimated that there should be about one such merger event per galaxy per million years, which implies about 100 such events per year should occur within the 3 Gpc radius suggested by the BATSE intensity cutoff. This is only a factor of 10 lower than the actual observed event rate, which is considered pretty good by astrophysics standards. The other thing the neutron star merger model has going for it is that the total energy release of a pair of merging neutron stars is estimated to be about 10^{54} ergs, most of which goes into the emission of a burst of neutrinos. It is argued that if 0.1% of this energy is channeled into electromagnetic energy, it corresponds to the energy release needed for the GRB source.

The problems with this model are (1) that it would normally produce a very thermal distribution of gamma

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rays that is difficult to avoid, (2) there is no evidence in the BATSE data of any periodic time structure such as might be expected from a binary neutron star spin-down and merger, (3) if even a small amount of normal matter contaminates the electromagnetic fireball which is expected to result from the neutron star merger, the fireball output is converted to energetic protons instead of gamma rays, (4) there are severe problems in accommodating the millisecond time scale, and (5) there are even more severe problems in accounting for the 25 GeV gamma rays that have been observed as a part of some GRB events.

Fortunately, this model will become testable in the near future. When the LIGO gravity wave detector (see my previous AV column) goes into operation in a few years, it should be able to detect the gravity waves generated in a binary neutron star spin-down and merger. These should correlate in time and spatial direction with GRB, if the neutron star model is valid.

My guess, however, is that GRB are *not* neutron star mergers, but something far more unexpected and exotic. I think Nature is sending us messages that arrive about every eight hours to tell us that the Universe is a far stranger place than we had ever imagined.

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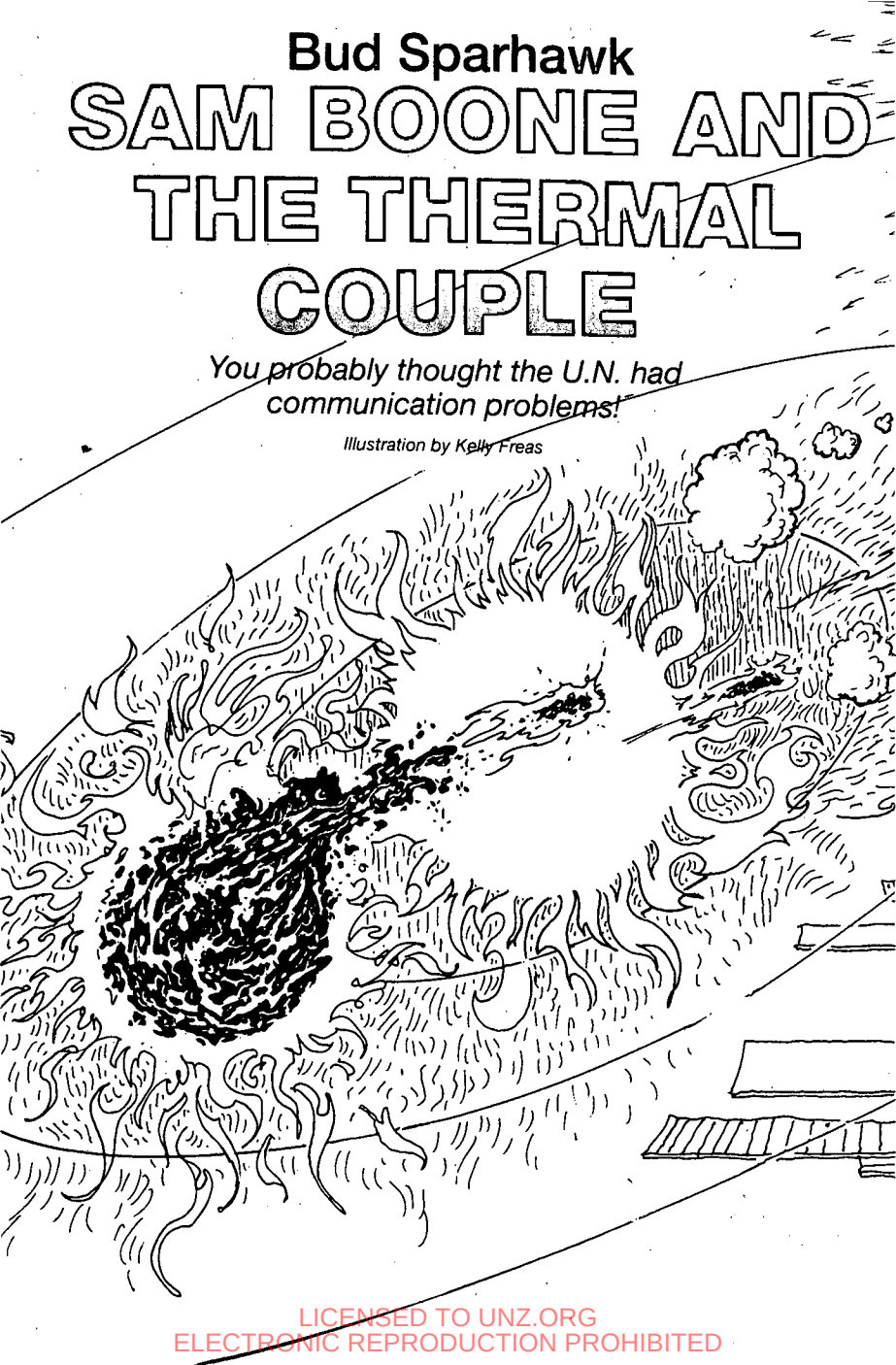
Bud Sparhawk

SAM BOONE AND THE THERMAL COUPLE

You probably thought the U.N. had communication problems!

Illustration by Kelly Freas



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In 2172 Earth managed to get one cranky and primitive starship a single light-year from home where, coincidence of coincidences, it managed to get itself rammed by a Stellar class cruise ship which was far outside its approved lanes.

The Greebnean owner of the ship was so anxious to avoid the galactic Hegemony's court system that it gave the human crew a replacement ship from the inventory as payment. "Never to speak of this event," it had pleaded desperately as it clamped the viewer for the ship's instruction manual over the captain's arm, thinking that appendage was the human's primary sense organ, much like its own. "Never to make a claim," it said in closing as it sent the remains of the ruptured Earth ship, the pinnacle of humanity's scientific and engineering genius, into the furnace of a local sun. It wanted no evidence of its transgressions hanging about.

Earth was ecstatic when the crew returned in their new ship, just three weeks later. The gift that had been placed in their hands provided enough engineering and scientific data to build an entire fleet of workable starships. Humanity could start to explore "local" space quickly and economically. Humanity could finally enter the galactic community and fulfill its destiny among the stars.

Much to its chagrin, humanity also discovered that far from being unique, intelligent life was quite common. Nearly all of the niches of life were already filled, as were more habitable planets (and quite a few that were only marginally so, like the Earth.)

The Galaxy was literally brimming with life in its manifold forms. The only thing that had prevented that knowledge from becoming apparent to mankind centuries before was humanity's strange methods of using electromagnetic radiation for communications, something most of their *local* races had abandoned early on because of the problem of static and the inverse square law. Besides, there were so many other obvious and cheaper methods, such as the phloomb-driven ansible.

Lacking any places to settle and exploit, and lacking capital to enter the markets of the Hegemony, human explorers and entrepreneurs flailed about for years trying to find a niche where they could earn credits and become a part of interstellar commerce, the market in primitive human gewgaws and souvenirs notwithstanding. After all, how many Mickey Mouse hats (the Hegemony's favorite item) could the galactic community absorb?

Finally Earth discovered its single marketable and very human, talent of negotiation—and began to earn valuable trade credits by sending arbitrators among the galactic community.

Sam Boone was one of the first of these.

Sam lay on his back in the lounge of the starship *Perlieu* with a cool bottle within reach on one side and a warm blonde on the other. Before him the immense sweep of the Milky Way arched like a brilliant sparkling rainbow across the velvet background of

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extragalactic space. The luxuriousness of the lounge and view were his very personal reward for the miserable months he'd had to spend on the fetid and overheated Scrofulous Five.

Even Ahbbbb, his supervisor, should have been happy. After all, Sam had finished the job nearly on time; normal for him and the reason he had become Ahbbbb's key negotiator in the Periglena arm, which is to say, the only human around for about a jillion or so cubic light-years. Sam regretted that she hadn't assigned him to some better venue, closer to home, closer to occasional human companionship. But life out here in the outer reaches of the Hegemony wasn't too bad: Ahbbbb could charge whatever she damn well pleased for his services and squeeze every centime from each transaction. His fee usually included the normal cash in advance, a cut of which went into humanity's trade account, some to Ahbbbb, and the rest to his personal account that she managed for him.

Usually all of Sam's accommodations and travel were taken care of in a non-revocable advance, with an occasional luxury or two thrown in for his trouble; which was why he was enjoying the cool bottle, the warm blonde, and the spectacular view. There were a few drawbacks to interstellar travel, however.

His ears popped as one of those drawbacks became reality. The sudden increase in pressure signaled the ship's arrival at his next assignment. He sighed deeply, squeezed the blonde one last time, took a swig from the bottle, glanced at the magnificent view, shook himself, and disconnected the leads at his temples. With a sad sigh of resignation he watched the rough, gray-speckled ceiling appear just a meter overhead as Milky Way, blonde, and bottle faded away from all of his senses. Little illusions like those were one aspect of Hegemony technology that made these trips in alien ships so bearable. Briefly, he wondered how long it would take before he became addicted—and then wondered if he really gave a damn: That had really been a nice blonde!

He wormed himself over to the annunciator, trying to keep his head from coming into contact with the rough surface of the ceiling, pulled a long pink tube from the wall, put it over his mouth, and blew hard four times in quick succession. He hoped that his lung capacity was equal to the task of depressing the tympanum of his steward, or whatever it called itself, at the other end of the communications device to alert it to the fact that he was ready to debark.

It would be a relief to finally get out of this terribly cramped compartment. The suite was luxuriously wide and roomy by the standards of the Needke, who were only one meter high and three across. Since he lacked the assortment of legs, tentacles, cilia or whatever they were that the Needke used for locomotion, Sam had been forced to crawl on his belly to get around the suite for the entire trip. He'd also grown extremely tired of eating out of his spartan and limited travel kit, a cuisine forced on him by his inability to digest the rock-like

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creatures that appeared to be the Needkes's sole food supply.

He'd also discovered to his dismay that the small dusty depression in the floor that possibly served as a Needke bed was of no use to him. Instead he'd used a soft pad he'd found in a compartment, and whose real purpose he had never discovered, as a bed roll.

The Needke toilets had been the worst part of the trip.

Soon enough the narrow entrance to the stateroom slid open and one of the Needke huffed a modulated puff of musty smelling breath toward him. Since Sam's ears weren't the half meter wide tympani that could convert the light breeze into anything with a semblance of meaning he assumed that the steward was informing him that it was time to debark. In eager response he grabbed the handle of his kit and dragged it out into the hallway, a narrow chute that he hoped would lead to someplace where he could finally stand erect. It would probably take weeks to work out some of the kinks that the long voyage had created.

The Ja'aar station where he emerged from the chute was a huge, compartmented helix of pearlescent hues. The Ja'aar had developed spaceships from the gas-filled creatures of their world. These not only had skins capable of surviving the vacuum of near space but used the production of various biological gases for propulsion. Some, such as this station, grew hard bony shells that could be used as permanent housing.

Every Ja'aar around him was twittering and chirping and trilling in a nearly unbearable cacophony of sound that echoed back from the smooth walls. Sam found himself confronted by a vaguely bird-like character with a twittering voice that endlessly repeated the same song, "La-la-la" over and over and over and. . . . He recalled from the prep tapes that these Ja'aar communicated by varying the tone and volume of their individual songs, the melody being each Ja'aar's individual signature while the overtones carried the information. As a matter of fact, he recalled from Ahbbbb's briefing that the last portion of each Ja'aar's name was the key of its unique song.

At the moment Sam could not understand any of the information this particular Ja'aar in front of him was trying to convey and looked about for the translator that was supposed to be waiting for him. He waved his arms in what he hoped was a clear signal of his confusion. Perhaps it knew where his translator could be?

The Ja'aar stopped its song, cocked its head to one side and silently observed the antics of the strange human creature for a few seconds. After a few moments of consideration it shrugged in an almost human way and began trilling the "La-la-la" welcome song once again.

Sam put his hands on his hips and glared at the warbling birdbrain before him. Finally, unable to stand that damned "La-la-la" tune any more he put his hands over his ears to shut it out. The Ja'aar leaped back and lifted

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its own tiny appendages to the sides of its own head and stared at Sam. The two stood thus for several moments until Sam, unable to bear it any longer, opened his pouch and extracted his certificates, which he thrust at the Ja'aar.

The tall creature peered at the papers as if unable to understand this turn of events. Finally it seemed to grasp Sam's meaning, extended a grasping limb, and looked over the documents, glancing every once in a while at the waiting human.

"La-la-la," it announced very slowly while indicating itself. Sam considered for a moment and then decided it was attempting an introduction; this one must be Ja'aar'la-la-la. "Sam Boone, human," he announced and stuck out his hand.

The Ja'aar leaped back as if struck. Quickly it looked around as if seeking help from the officious Ja'aar racing toward them, tweeting at the top of his voice. Sam dropped his hand to his side as a tough-looking Ja'aar with a black band on its leg and holding what appeared to be a weapon of some sort, grabbed the papers from the trembling Ja'aar'la-la-la who was continuing to chirp at a furious rate; "La-la-la, la-la-la, la-la-la, . . . "

"Tweety-twee-tweet," the police-being trilled as its small translator repeated for Sam's benefit, in barely understandable Glax, "Why you threat to Ja'aar'aaa? You his responsibility." Sam assumed that Ja'aar'aaa was the name of his greeter: Sure, "la-la-la" must be "aaa."

"I didn't do anything," Sam protested with a shrug, taking care not to point at anyone in particular. "I'm just trying to find out where I'm supposed to go and who I am to meet."

"Tweety-twee-tweet," the police-being replied to Ja'aar'aaa. "Take it to its quarters, stupid," and threw the papers back.

Sam knew that his escort felt comfortable when it returned the documents to him with a little bow of the legs, turned its back on him, and began to lead the way out of the arrival chamber. Still, the Ja'aar looked back frequently to ensure that Sam was keeping a proper, non-threatening distance away. It appeared that a Ja'aar could never be too careful with aliens.

Sam was relieved to see the promised translator hanging on the wall in his compartment. It even had a decent set of human-shaped earphones attached. Clearly someone here had figured out what he required, unlike those other cretins who had arranged his ship accommodations and sent Ja'aar'aaa to meet him without the translator in hand, er, wing. He clamped the earphones on quickly to understand what his escort had been saying.

"This room is the very, extreme best we could arrange," twittered the translation of Ja'aar'aaa's chirping over the earphones. "We have furnished it with every luxury we could afford." It hopped over to a large tee-shaped artifact and stoked it with one appendage. "Oh wonderful. This is one of the finest perches that I, Ja'aar-'aaa, have ever seen. How I envy the rest, honorable Ear't negotiator," he

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prattled in an endless repetition of that same damn song, "La-la-la, la-la-la, . . . and on and on and on. . . .

"And here is your drinking vessel," it chirped with a sweep of one flexible wing at the incredibly cut crystal water bowl hanging from the wall at its own chin level, about a meter above the top of Sam's head. *Well,* thought Sam, *maybe I'll find something to dip a drink with whenever I'm thirsty,* and cursed the diversity and insularity of the interstellar community that made accommodations so chancy. In vain he looked around for something he could use as a chair to reach the water bowl.

He wondered, with apprehension after another glance at those long legs, what a Ja'aar toilet would be like.

Ahbbbb, his supervisor, had made the assignment sound so simple. "Travel to the Ja'aar station and negotiate an agreement between the Suture and the Gunny-sacks, or some names like that," Ahbbbb had hummed with ill-concealed glee at sending Sam ever farther from Earth, probably in retaliation for the worry he'd caused her over the past years. "It'll be a simple matter, really. They just want the cachet of an Earth negotiator, is all. Shouldn't take you more than a month, two at most. We'll make a healthy profit on this!" Sam knew, all too well, that thoughts of such profits were what made his supervisor so jolly. Ahbbbb had frequently flensed Sam's expenses to the bone to squeeze some profit from his previous "nearly-on-time" ventures, which made him suspect that she possessed a heart only somewhat larger than the end of this sentence.

But a brief explanation of the facts showed that she was not far from the truth, even if she did have the names royally screwed up. This appeared to be a really trivial matter. More importantly, both races had paid handsomely. "Every confidence in the Earth-thing to work its wisdom and powers," had been the flattering words the Ja'aar intermediaries had sent along with his advance for six months of effort, with more promised if a protracted stay was required. Hah, he thought, *Even he wouldn't need any longer than that.* Ahbbbb had promised that if he could somehow manage to wind this one up on time for a change he could walk away with a healthy profit, enough to get back to Earth and find a real bottle and blonde to replace the illusions.

"Who can translate for the delegates?" he asked and was startled to hear his words emerge from the translator as his catchy little signature tune; "Bum-da-bum-bum-da-dah, da-dah."

"Er, no one," came the alien's terse reply through Sam's earphones. "There are some, uh, difficulties."

The seeds of suspicion that this assignment might not be so straightforward were suddenly planted in Sam's head. "What do you mean? The Ja'aar are supposed to be the intermediaries for them! You are taking care of them. Certainly someone must be able to talk with them."

Ja'aar'aaa hopped from one leg to the other as its head bobbed up and

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down. "Most difficult to do. We feed them. We bring health. We try." The bird-like being's song dropped dramatically in volume; "But talk we cannot. There is not means."

Sam's suspicions were now growing quickly. "You have not communicated with either of the races involved. Surely you have the translators—"

"Not the means, not the words. None can do it. We are without the means."

The seeds of suspicion were now starting to flower. "Take me to see the delegates," he demanded. BUM-da-BUM-BUM-da-dah, da-DAH!, his translator repeated.

The walls of the Gunny-sacks a.k.a. the Ginnungagup delegates' containment tank stretched upwards into the dark recesses of the vast chamber near the outer ring of the station. The condensation on the outside of the container's thick walls belied the chill temperatures and high pressures within. "Methane breathers they are," chirped Ja'aar'aaa. "Large things who float inside. They boom loud and monotonous. We can hear but not understand."

Now that it had been brought to Sam's attention he noticed the steady vibration coming from the tank—a low-frequency drone that went on and on. It was even more boring than the twittering of the Ja'aar.

On the other side of the chamber, sitting isolated and alone, was a tiny, reddish box-like affair. Sam started to approach it when Ja'aar'aaa touched him on the arm and chirped a warning. "Not to go close to the Sutr, respected Ear't." Sam shrugged off the touch and continued. How the hell was he supposed to be a negotiator if he couldn't approach his clients?

The heat hit him in the face when he was still twenty meters from the box. With each step closer the temperature increased further, making sweat break out on his forehead. Apparently the box's reddish hue was due to radiation, not coloration.

What sort of beings could possibly live in such an environment, he wondered as he stared at the radiating compartment? He looked back at the huge tank booming at his back and then again at the small box; The living conditions of the two races had so little in common that physical confrontation would be impossible. What could two races such as this possibly have in common that would be the basis for an accord?

His suspicions that this would be no trivial job were now in full bloom. He might have to ask Ahbbbb for that extension of time after all, and suffer the consequences as well.

The facts surrounding the accord were simple. Apparently the Sutr had established a settlement on the innermost planet of "their" system and were developing it as quickly as they could, spending much hard-won credit to extract the rich lodes of minerals the tidal pressures and broiling temperatures brought to the surface.

The Ginnungagup, on the other hand, had found a nice cold planet in the outer fringes of the same system. Their planet's temperatures were so low that water ice was as hard as steel. They too had spent a large for-

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tune to develop the resources of "their" place and establish their own settlement.

The expenditures of both races on their respective planetary development had been small by galactic standards, where kindling of new stars was considered to be a minor, local construction project.

Soon after they had invested heavily they had both discovered, much to their surprise, their next-door neighbors. Not only that, but those neighbors had turned out to be hideous, horrible, ugly aliens who inhabited each other's version of hell!

The situation was intolerable. A brief war ensued in which the Sutr and the Ginnungapup steered comets and various debris at each other, posted glims of ligitous (whatever the hell they were) with the region's races, and blocked each other's shipping routes.

The squabble had expanded to include a few nearby systems, with the Sutr and Ginnungagup fleets firing upon each other and attempting to deny the other any possible base of operations. This latter had a definite effect upon real estate values, which was not looked upon kindly by the indigenous races. Clearly, the dispute was in danger of coming into the awareness of the Court, a possibility that sent fear through every race in the area. On the brighter side, many of those races thought, perhaps one would destroy the other and end the matter gracefully and painlessly, as far as the rest were concerned.

In the end the court did intervene and a Dre't, the court's enforcer, was sent to pacify the disputants until the court could rule. Luckily significant numbers of both races survived the Dre't's intervention.

And damage to nearby systems was minimal.

The court promised that the case was going to get a speedy trial in light of the urgency of the matter. In fact, the court had graciously moved the date to the earliest spot on the docket—a mere four hundred Earth years hence! It was no wonder that the local races wanted a settlement.

Two forces made Sam's mediation talent so valuable. The first was the Hegemony's millennial court backlog, which averaged about seven solar centuries or so before the initiation of adjudication, and usually another five for the actual proceedings. The only thing that kept this backlog so short was the limited lifespans of most of the plaintiffs, which often resulted in evaporation of cases long before they ever reached the judges themselves. Rather than wait for the courts, some parties just wrote off their problems and went on with their situation as best they could. The concept of lawyers had been the one blessing that the rest of the Galaxy had been spared.

The other forces that made Sam's arbitration talent so important was the fact that the court often found in favor of the Hegemony, meaning that both parties lost claim to the item under dispute—and had to pay enormous fees to boot! After all, twelve to fifteen centuries of court costs can add up even at low hourly rates.

And low hourly rates had never

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been approved by the court.

It didn't take much convincing for the other races to agree on transporting a few members of both the Sutr and the Ginnungagup to a neutral system for a speedy Earth-mediated accord.

Nobody knew what the Sutr and the Ginnungagup thought about the matter.

As Ja'aar'aaa explained in an endless chirping monotony, the Ja'aar had no translation mechanisms in common with the Ginnungagup since they had never had trade links. "La-la-la, la-la-la,. . ." Ja'aar'aaa trilled in apology; "We have requested that an Imperial, another nearby race, deal with the translation. The Ginnungagup have had trade with them."

But that wasn't the only problem, Sam learned soon after the Imperial's arrival. The Sutr had also been incommunicado since their arrival. Ja'aar'aaa hadn't bothered to mention that the superheated beings could not communicate in any of the local modes. It appeared that they used plasma exchange as their communication medium, a feature that would incinerate anyone trying to use the standard translators. Sam began to understand why the galactics wanted a "neutral" meeting place; either planet would be intolerable to the other.

Sam patiently spoke to his supervisor over the ansible, explaining just why he needed a slight extension of time to settle this simple matter. He could see his profits shrinking and his hardships growing as her voice lost the merry humming overtones. "I'm sure that you will be certain to find a way to make a profit on this, won't you?" she demanded with a small hint of menace in her chilly closing.

"Of course I will," Sam replied. "Trust me."

It turned out that a Rix engineering team just happened to be at a nearby system and could be diverted to help out, for a slight fee, as their leader Sslivira had chirped with enthusiasm in answer to Sam's inquiry. They had considerable experience in dealing with extremely high-temperature environments and could easily construct an appropriate interface for the Sutr. Naturally, the Rix clicked over the ansible, they would have to cancel some very lucrative work to aid the effort, compensation that it was certain that the Earth-thing would willingly provide. With a groan at their quoted price Sam agreed to fund their assistance. They assured him that they would be there within the week.

The Rix proved equal to their promises and constructed the interface in short order. Four days after they finished Sam gathered the principals of the three races around him in the conference chamber, an opaline room of small dimensions near the center of the station. To his right was Ja'aar'aaa, perched on a small conference tee that brought its head level with Sam's. Across the table, squatting on the floor so that its "head" was even with the others, was Sallow Yellow Orange, an Imperial. That delegate's visual organ continually scanned the room as his communica-

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tion organ blinked lazily in its listening mode.

On his left, and standing on the table, was Sslivira, the tiny Rix chief, its mouth parts moving continually as it chirped and mumbled to itself.

"All right, let's go over the problem one more time," Sam said to the members of the three races. He waited for the collection of translators before him to finish; "bum-da-bum-bum-da-dah, da-dah, clickety-clickety, click, click, click, blink, blink blinkedy blink." Clearly he would be having a very hard time keeping up with the conversation if it got any more complicated, Sam thought as he waited for the devices to finish.

"Now, have we established the necessary links between the two parties so that I can begin the negotiations?" he asked with a short prayer under his breath.

"Blinkedy, blink, blink. . . . " went the Imperial. "Unfortunate. We have difficulty with communication. Cannot understand meanings of the words from the Ginnungagup's tank when they confer and discuss with me. Conceptual difficulties at high levels."

"Perhaps it is a matter of cultural referents and not simply language," Sam suggested. "We are all atmosphere-breathing, very two-dimensional creatures." Ja'aar'aaa fluffed its feathers angrily as he continued; "and these Ginnungagup beings are clearly three-dimensional swimmers. Perhaps we need to bring in someone with similar characteristics?"

"Excellent suggestion," Sallow Yellow Orange blinked. "I knew the Earth-thing's genius would find the solution." It rose on all six elephantine legs and shuffled from the room to

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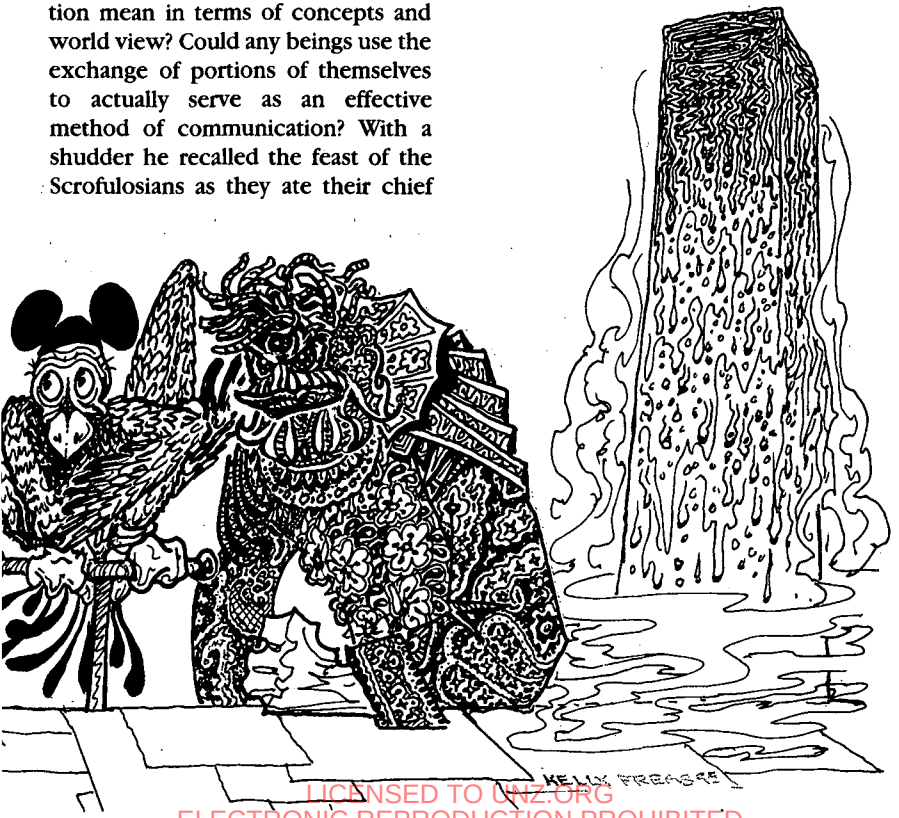
find out where their group could obtain such a intermediary for the project. Somehow Sam knew that there would be a cost attached to whatever it came up with.

The Sutr were more of a problem. The creatures inside the hot box lived on the thermal boundary between plasma and gas. Sufficient organization existed in portions of the swirling interior that could be defined as individuals, although, on occasion, small portions of each would break away and be captured by another. Was this another means of communication, he wondered, and what would that method of communication mean in terms of concepts and world view? Could any beings use the exchange of portions of themselves to actually serve as an effective method of communication? With a shudder he recalled the feast of the Scrofulosians as they ate their chief negotiator at the end of each day to gain its knowledge and insights. He acknowledged the possibility.

"Click. Click-click, clickety. . . ." Sslivira, the Rix cut in on Sam's thoughts. "Every attempt on my part to converse has brought no reaction from the Sutr delegates. They have been unable to gain any sort of meaning from our attempts." Its wing cases drooped despondently as it concluded. "Nor we from theirs."

Sslivira agreed that communicating on the conceptual level might be a problem. "Have built a device to speak with them," it clicked, "but



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cannot understand their language. Must find other translator." After a few more moments of syncopated discussion Sslivira leaped off the table and skittered from the room to research possible races that just might have a language and concepts in common with the Sutr, and which might just be affordable, even with the normal Rix markup!

Sallow Yellow Orange arranged to divert a ship of Garnerians that was passing within a few light-years of Ja'aar to serve as possible intermediaries. The Garnerians were, he assured the growing negotiating team with a display of dazzling color, the huge and hairy inhabitants of an ocean world and would undoubtedly share many conceptual views with the Ginnungagups.

Sslivira meanwhile was still searching for some reference to creatures who might have a language in common with the Sutr. The best she could come up with were the Resnicca; gaseous windbags who eternally orbited Gruenbrgg, their primary.

"They spit at one another?" Sam's translator clicked in amazement as she explained how they communicated.

The Rix spread her vestigial wings in reply, which meant yes. "Is termed venting. Necessity in near vacuums at outer fringes of their atmosphere."

"How would the translator handle spitting?" Sam asked incredulously. "No, don't tell me. I really don't want to know!" He decided that he was definitely going to request still another extension from Ahbbbb no matter how mad it made her.

Still, the fact that these Resnicca also lived in a three-dimensional environment was an added plus. Perhaps that would allow them to even translate some of the Ginnungagup's concepts more successfully.

Sslivira set her engineers to busily modifying the interface as Ja'aar'aaa arranged to bring the Resnicca from distant Gruenbrgg.

The Garnerians arrived in a ship so huge that it nearly matched the station in size. At the center of the ship was a vast globe of water, held in place by a skeleton of spars and arcs that glittered and glowed. "Field effects holds liquid in place," Ja'aar'aaa warbled knowledgeably as it and Sam observed the ship's stately docking. A day later Sam watched in amazement as one of the vaguely whale-like creatures gracefully manipulated its bulk along the liquid passage they had extruded to the face of the Ginnungagups's tank.

Within moments of the Garnerian's arrival the interface began to boom loudly. Immediately the Ginnungagups responded, sending wave after wave of pressure back toward the interface. The deck shuddered with the vibrations of the conversation as the dialogue went back and forth. "Hot damn," shouted Sam, "Now we're getting someplace!" It had been worth the month's wait for the Garnerians to arrive. Maybe he could still bring this in on time after all.

"La-la-la, la-la-la, la-la-. . . Honored Ear't, we have small problem," were the first words that Ja'aaa'aaa brought

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to him the next morning.

"What do you mean?"

"Is Gar-ner-ans. Did not know that Rix was part of this. Sorry to be here, they are."

Sam sighed "What's the problem? They don't even have to speak to the damned crickets, er, I mean Rix—Bum-da-BUM-da."

"Is that they look so bad," Ja'aar'aaa said plaintively. "They offend the purity of the world."

Sam felt like screaming. "But the Garnerians are ocean dwellers! They aren't even connected to the damn life support systems on this station, for Pete's sake!"

Ja'aar'aaa drooped visibly. "Is wrong words? They ask if we do not smell the Rix so horrible?"

Sam was puzzled by the Ja'aar's response. "How could they smell the—Wait a minute!" He thought that if the Garnerians communicated by sound, just as the Ginnungagup did, they would have a highly developed sonar sense. Sure, light wouldn't penetrate very deeply into their atmosphere so they would use sound to both "see" and hear. Now, if they heard the Rix chirping wouldn't they interpret it as a "visual" image?

"Tell the Rix to cut themselves out of the Garnerian's translation circuit," he directed. "Tell them that they will have to work through me."

Ja'aar'aaa brightened visibly. "La—" it began.

"Just do it!" Sam yelled and covered his ears to block the song that was becoming all too familiar.

Ja'aar'aaa returned later that day with even worse news. "My attempts to bring the honored Resnicca to our humble station have not been exactly successful," it chirped woefully. "There is no transport available to bring them the seventy light-years from their planet."

"Then set up an ansible link!" Sam responded instantly, before thinking of what *that* would cost him. Clearly, with the Hegemony's nearly instantaneous phloomb-based communications such a link was possible, but whether it could be used for continuous translation was a question that he'd never considered. The Ja'aar raced to do his bidding with Sam's charge chip in hand.

"Are you sure that your interface can be hooked to an ansible?" his translator chirped plaintively to Sslivira later that day, hoping that the Rix and Ja'aar engineers were up to the effort. "Click, clickety, click, da-da-da, da-da-da" the two agreed: "It is possible."

He had time later to wonder what in the world the interface at Gruenbrgg would be like. Maybe, he thought with a shudder, he'd rather not know.

Sam fumed as the days dragged on. All of this damned positioning and increase in team size was eating up his profit as well as ruining his disposition. To make matters worse, he still couldn't use the Ja'aar toilet in his suite, luxurious though it might be. Ever since he had arrived he'd had to use the transit facilities in the nearest common chamber, which was damned inconvenient, not to mention crowded with other inconvenienced

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aliens. His periodic trips to the facility must have been confusing to the Ja'aar, who could easily conclude that humans had some very strange social habits to go with their weird appearance. He occasionally considered asking Rix engineers to construct a human toilet for him without letting his hosts know, but dismissed the idea since he was sure that he would be around that much longer.

Then again, maybe he should reconsider.

The Ja'aar engineers grew an insulating shell about the Sutr's habitat and brought the temperature nearby down below the boiling point. Within this shell the Rix team had placed a confusing array of lights, pipes, tubes, and other apparatus that Sam couldn't hope to describe adequately. A small furnace and smelter appeared to be hooked up to a thick torus that was pressed tightly against a wall festooned with a variety of various sized tanks and containers.

"Is analyzer and fabricator," explained Sslivira in her rhythmic clicking speech. "We capture, we analyze, we transmit. The Resnicca's exhalations return and we blend the response from the supply attached. Awkward, but possible to work."

Maybe it would and maybe it wouldn't, Sam thought as he sketched out the tortuous chain of translation that would take place with each bit of dialogue: To speak to the Ginnungagup he had to first translate his speech into Glax, by now almost a second language for him, so that the translator would work—humans didn't comprise enough of a population to make it worthwhile programming their languages into it. The translator would convert his Glax to the blinking lights that Sallow Yellow Orange could understand. The Imperial would then somehow transmit(?) its version to the Garnerians who, after consultation on the meaning, would boom their understanding of the transaction through the interface of the Ginnungagup. A response would follow the same tortuous chain back to him, with Sallow Yellow Orange and the Garnerian trying to figure out what had been said and how to translate that into something that the tiny human brain could grasp.

How in the hell had he expected this to work? It had proven to be like those old games of his youth where you would whisper a story to the person beside you and have that person pass it on. By the time it went through four or five parties the story would have changed beyond belief. If the same principle applied here then what hope did he have of achieving understanding between the two? Where the story passers at least had common language and culture, this cobbled-up arrangement had none.

Sam recalled their first attempt at a dialogue. "What are your objectives?" he had said in Glax so that the translator could turn it into clicks and blinks. After that he watched in wonder as Sslivira and Sallow Yellow Orange started to work on their sides of the path. His translator gave him some hint of each interface as the two consulted with their conceptual helpers.

According to his translator the Im-

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perial had flashed to the Garnerian "[?] . . . spectrum of . . . [?] . . . with brilliance . . . [?]" The Garnerian pondered these words for a moment and boomed a reply at a frequency just far enough below Sam's level of hearing to give him an enormous headache. Several more interchanges of confusing dialogue took place before the Garnerian finally activated the interface and boomed out something to the Ginnungagup that rattled everything in the station.

Moments passed before the thundering reply began, which the Garnerians immediately rephrased for the Imperial who had turned to Sam and blinked sadly, "Cows are wettest in the Spring tides."

He shuddered when he thought of what had come from the other side where gasbags and plasmas engaged in a long-range spitting contest. Their nonsensical reply had been etched into his mind. "Sweet rides the death of flavor."

From such modest beginnings grew a dialogue that, despite massive nonsense and setbacks, occasionally began to make some sense. They had, for example, established identification of each other's names and Sam's role in the matter.

There it seemed to stop for days on end as the giants boomed and shook the station with their exchange and the spitting, fuming cage flashed and sent out blasts of heat. It appeared that anything beyond very basic exchanges of facts between the two races quickly grew into a mass of misunderstandings and miscommunications. It was almost as if some unseen force was bent on frustrating and confounding the efforts of one poor human negotiator to wring an agreement from the pair.

Needless to say, Ahbbbb was growing very displeased with his progress.

A week later, and considerably further into his profit margin, Sam was even more frustrated. After the latest blast of the torus into the chamber as a result of a Resnicca exhalation light-years away, the Sutr glittered briefly as bits and pieces were thrown back and forth among themselves. From their reply to his latest query he could tell that Lattice 5^{12}, the leader of the Sutr, wasn't able to understand the concept of compromise. From what he understood of what Lattice 5^{12} was saying, the hateful aliens could not be trusted to keep any agreement. "Cold without salt," was the metaphorical translation. A promise from the Ginnungagup to schlep around the outer fringes while the Sutr basked in the photosphere of the sun mattered little to them.

Nor had Sloosh, that frozen blimp who represented the Ginnungagup, seemed to grasp the idea of sharing the system with the Sutr. "Holding the warmth of my God," he had boomed through the translation chain in a surprising burst of near clarity that startled Sam and gave fragile rise to hope that there had been a communications breakthrough of some sort.

That clear statement at least made some sort of sense; implying that the cold creatures had a religion. Only later did he come to realize that it was not a Ginnungagup translation at all.

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It had been the intermediary Garnerian's request to be excused to go to the (bathroom?).

Sam wondered for the hundredth time in as many days what he had gotten himself into. It was starting to appear as if even the extension grudgingly won from his supervisor wouldn't give him enough time to complete this assignment. "Why the hell can't we find some basis for a dialogue?" he clicked, chirped, and flashed to his multiracial helpers.

The flashing, clicking, chirping response was almost too much for his tiny translation machine to handle, but the sum of their statements ran like this. "Conveying information is more than simply ensuring that the words are correctly spoken. It is also necessary that the proper concepts be conveyed by those words."

"Apparently neither of the parties have *any* metaphors in common," blinked the closing phrase from Sallow Yellow Orange.

Sam considered this with some skepticism. Every civilized life form had the same six basic needs: nourishment, protection, reproduction capability, socialization, acquisitive greed, and a trip to Disneyland on Earth. In every dispute he had ever mediated one of those had been the basis for achieving agreement between something entirely new in the Universe, he should be able to find the common ground for agreement in at least one of these areas.

But which one would it be? Habitat was out, as was nourishment, for anything that the Ginnungagup could eat would be destroyed by the temperatures of the Sutr's environment. Likewise nothing the Sutr ate (absorbed?) would be recognizable to a Ginnungagup. It was entirely logical to him that the two could share the system without ever impacting on each other. The inner planet had an orbit that carried it practically through the photosphere of the sun and baked its residents at temperatures where even basalt flowed like water. He tried to picture Lattice 5^{12} and his buddies going to the edge of a sea of boiling iron, spreading out their plasmoid blankets and getting a nice rosy glow to the plasma shell when the temperatures were right. Could be a great market for sunscreen, he guessed. But, of course, it would have to have an SPF of forty billion or more, he mused.

The choices left to him were sex, socialization, greed and The Trip. Briefly he thought of the flaming embrace that would ensue should sex or dancing be attempted between the two and then dismissed it. Sex was out, which left only three choices.

Of course the big Gee was the thing on which they disagreed, at least the Sutr disagreed; the Ginnungagup were more agreeable, or so he suspected from what he could make of their oblique communiques.

So the basis for compromise lay with socialization. Somehow he must establish a bond between them, a reason for cooperating and sharing the system.

"I think I have something," he clicked to Sslivira. "Ask them what is the most valuable aspect of their society." If nothing else the question should establish some benchmarks

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for their social values.

The Rix wiggled its wing cases in a pleasure movement at finally having something meaningful to do, even if it didn't understand the relevance to this issue. She clicked excitedly at the link to the distant Resnicca. Sam's translator could pick up a few fragments of what she was saying, " . . . Hold above the sun . . . holding . . . the essence. . . ." Although the words made some sort of weird sense he could not grasp the concepts implied within. A gas-filled bag, floating in space around a gas giant couldn't possibly have any artifacts save its own skin. Clearly the Rix was converting his inquiry to something the Resnicca could grasp.

Presently a whisper of a sigh returned over the link and the Rix brightened considerably. It activated the array that had been set up within the Sutr's environment and watched as the oven and torus pulsed a glittering stream of ionization at Lattice 5^{12}.

Some sort of response must have been affected, for the Sutr began sparkling and shining among themselves as if someone had turned on the dance lights in a darkened ballroom. The analyzer spun into activity as a reply was formulated back to Gruenbrgg and the waiting Resnicca. A few moments later there was a burst from the ansible and Sslivira brightened. Turning to Sam she clicked the translation; "Brightness falls short of the just. Bring a spectacle to the party."

The Ginnungagup's answer was more direct. "Soft music in the [?]."

After another week of probing exchanges Sam had learned more about the mating and procreational habits of the Ginnungagup than he knew about his own species. Meaningful information regarding the matter at hand was severely lacking, however, as was progress in getting them to state basis for settlement. There seemed no arrangement of trade or commerce that was acceptable to them. It seemed that they could not "deal with the devil." That last translation was the best Sam could understand it.

The Sutr were similarly forthright. Their preferences for feeding were explored in exquisite detail. Sam recalled the four-hour session where they learned the seven hundred nuances of a mercury mist, the twelve hundred distinct flavors of monatomic hydrogen-*with,* and the degrees of basting required to extract the maximum pleasure from gaseous carbon. They, too, refused to consider any sort of compromise or interface with their unspeakable hideous and untrustworthy neighbors.

None of which helped him in the slightest. It looked like the court was going to be their only chance, which meant that bonus, profit, bottle, and blonde were all equally unobtainable.

Ja'aar'aaa hopped into Sam's suite excitedly, chirping its song so rapidly that Sam didn't recognize it until he had the translator firmly in place. "La-la-la, la-la-la," it said; "Great news, Ear'tman, one of your kind will coming to us for help!"

"Another human?" Sam asked as he rubbed sleep from his eyes.

"Yes, yes. One of the Ear't kind coming to help. She arrive tomorrow."

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Sam's heart raced as he considered the news. It had been years since he'd seen another human that wasn't one of his illusions. "Wait a minute," he said as he suddenly realized the full force of Ja'aar'aaa's words. "Did you say *'she'* is coming?"

The bird-like head nodded vigorously in a very human fashion. LA-LA-LA; "Yes. She, indeed. Have seen pictures of human female. Most certain a she person!"

Visions of feminine beauty filled Sam's mind. Would she be a brunette, dark and sultry? Or a redhead, all fire and storm? Or (oh hope springs eternal) was it possible that she could be (please, please) a . . . a . . . a blonde?

He leaped up and looked at his face in the mirror, wondering if he should shave off the beard or leave it on. Maybe a haircut would help reduce the gray a little. And he'd have to find some better clothing, maybe even some that was clean. Wouldn't want to look like some slovenly Earthman gone to seed in the hinterlands, would he? No, he had to make a decent impression. He started whistling to himself as he laid out the plans for entertaining his guest—by God, another human! At last!

"Her name," chirped Ja'aar'aaa gleefully, happy that the Ear't negotiator appeared to be so overjoyed at its news, "is Ahbbbb."

Sam's Pequodista supervisor perched on the edge of the table. Only a muddleheaded, birdbrained, alien idiot would mistake the rippled, ridged, and gray-skinned Peq for a human, Sam thought as he stared at Ahbbbb's alien form. Nor had any human in memory ever had the bladders she'd inflated on the sides of her neck.

The writhing mass of worm-like appendages on her head strummed those air-filled bladders as she hummed to Sam. "Hmmmmmmm mmmmmm mmhmmmmhh muuuummmmmmmph, hHrummmmh?" which translated as "What the hell have you been doing with our money all this time, Sam?"

Sam stood his ground and answered her. "There have been some difficulties with the translations," he said, wondering why she had bothered to personally come all of this way to investigate a relatively minor matter. "Hmmmmm mm dhmmmmmr —However, we are making progress."

The Pequodista glared at Sam with her three compound eyes. "I do not consider the expense of five races, an open ansible link to Gruenbrgg, and the cost of your luxurious personal quarters trivial. Already this project, not to mention my involvement, has eaten up nearly all of *your* share of the profits."

As Sam mulled over her strange business math she continued, "Now I am fed up with these delays. I want this matter closed within a fortnight. Ahmmmmm fhmmmm yhmmmmm! Do you understand?"

"Ahmmm," Sam replied, seeing the blonde and the bottle disappear like Ginnungagups trying to tryst with the Sutr.

"Remember," Ahbbbb hummed as

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she walked out of the chamber toward her suite. "Two weeks: No more!" Hmmmmmt, hmmmm. Nhmmmm!

"Pleasant being, I think?" twittered Ja'aar'aaa as the hatch swung shut behind her. "Not nasty as you told us."

"Yesss," clicked Sslivira. "Most gracious to give you so much leeway."

"Do you want me to find out when the next ship leaves?" blinked the dour Sallow Yellow Orange.

One week into the deadline and Sam was no closer to the heart of the matter than he had been before. No matter how he phrased it neither of the races seemed to trust the other to keep any agreement that they might make. How could two star-faring races be so obtuse when it came to a simple matter of understanding that they had no basis whatsoever for conflict; no reason for their silly war? How could the matter of simple possession of a system be so important that it overlooked the facts of each race's differing environmental needs? Was their stupid alien symbolism so important that it overrode all other considerations? How was he expected to find the middle ground on which the two could agree?

He stopped cold. What was that thought? "Middle ground?" Something was suddenly making itself felt among the few remaining cells on his overworked brain. Maybe *how* had never been the question; perhaps the *real* question he should have been asking himself was *why!*

And once he knew what the question must be the rest fell immediately into place.

"Bum-da-bum-bum-da-dah, da-dah, clickety click clickety click click, orange, green, green, blue, purple, white—Yahoo!" he yelled and leaped from his perch onto the table. Sslivira dodged away from his dancing feet and scurried to the opposite end.

"Listen to me," Sam said to the astounded aliens, who must have thought that he had taken leave of his senses. "I know what we have to say to them!"

Hours later the team was in place with all three of the team members looking expectantly in his direction. Even Ahbbbb had come to the chamber to see what her agent had up his sleeve.

Sam looked around to make sure that everything was in order; this was no time for a screw-up. He cleared his throat and spoke very softly into the translator, pausing periodically for the clicking, chirping, flashing machine to finish before he continued. A further pause was required while he waited for the long translation path to be completed through the Garnerians and the Resnicca to the waiting Ginnungagup and the Sutr. It was an arduous and exhausting way to work but it had to be done precisely if he was to have any chance of success.

"On the shore is a rock," he began. "When the tide is in, the ocean possesses the rock and holds it dear." He paused as the translation proceeded. The Sutr, if his guess was right, would conceive of the sea as the sun that blasted their world's surface with its blazing photosphere. The analog of

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the tide would be that world's periodic bath in the fiery heat.

At the same time he hoped that the Ginnungagup's world had a shore and a primary that gave some semblance of tides. Certainly they had some sort of periodic ebb and flow that would make the metaphor work. The last rattling bellow from the Garnerian translator finished just as the torus over at the Sutr habitat stopped its spurting.

"But when the tide goes out," he continued, "the land owns the rock and does as it will with it." He waited until the tortuous translation of the replies finished.

"We understand," was the reply. Actually the words were more like, "The taste is pleasant," and "We share a womb," respectively. Sam waited a long while to give them time to consider his words.

"Mhmmmm! Hhhmmmhm mmh! Well, dummy, finish the story!" Ahbbbb drummed with impatience.

Sam looked at her and smiled. "It will cost you," he said slyly as the translator hummed away.

Ahbbbb turned an even darker shade of gray. "All right," she said finally. "Even share of the profits!"

"Excellent offer," Sam responded and turned to his team. "Now translate this as precisely as you can," he instructed, and waited while the three prepared their links. Ahbbbb fidgeted even more as a menacing hum began tó build from her bladders.

"There is no rock!" he declared simply.

Pandemonium reigned as the translation rocked along the line, with each translator instantly understanding the metaphor in their own environment. The thundering from the large container and the sparkling and glistening inside the smaller one showed that his point had been scored. The responses came back quickly. "A bland taste is none," the Sutr acknowledged. "The cow is absent," the other boomed.

They would ignore each other's existence. The dispute was over.

Ahbbbb drummed her bladders in satisfaction as she waited with Sam by the embarkation chamber for their respective transports to arrive. "Hhmmm, mmmmhm, mummmm. A most salutary solution to the problem posed by the aliens. You are well worth the outrageous sums we demand, Sam. I am continually amazed at how you manage to win success from absolute failure and cheat me of my profits."

Sam scuffled his feet in embarrassment. Since the final breakthrough he had been subjected to a constant barrage of congratulations from every alien within the station: The Ja'aar turned their backs on him whenever he passed as a gesture of respect and trust; Sallow Yellow Orange flashed a blinding litany of praise; and even reticent Sslivira clicked a constant cacophony of respect.

It was nice to be appreciated, but what he really longed for was some distance from these ubiquitous alien presences. He longed for the company of his own kind—even if they were illusions. Not to put too fine a point on it, but even Ahbbbb was starting to look pretty good to him

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after all of these other exotic forms.

"But what made you think of it?" she hummed. "How did you grasp on the precise metaphor that they would both understand?"

"Oh," Sam said with a hint of modesty. "Let's just say that it was a littoral translation."

"I still don't understand why you felt that you had to come out here to deal with me directly," Sam hummed to Ahbbbb. "An ansible link would have been a lot cheaper, and you wouldn't have to lose so much time from the office."

Ahbbbb's bladders fluttered with embarrassment as her appendages drummed out a stuttering reply. "This was not the reason I had for coming here. There is a problem that needs your special attention." She paused for a moment. "I needed to come out here to finalize the matter. It is the biggest commission we've ever seen; far larger than you can imagine. It is such an honor for you to be selected, not to mention costing me a fortune in bribes and contributions. And all you have to do is accompany the ship to help them with whatever they may encounter."

Sam whistled when he heard the outrageous sum she mentioned. "So where is it I have to go this time?" he asked. "The other side of the Galaxy?"

Ahbbbb's bladders fluttered nervously as she drummed her reply. "Not the other side of our Galaxy, Sam." Pause. "This is a *local* trip."

"I insist on decent accommodations," Sam declared, trying to keep himself from getting screwed this time around. He wanted to prevent her from booking him on some cheap liner for a long trip as punishment for tricking her out of "her" rightful take of the profits.

Yeah, and he didn't want to wait until he returned to see any of his share. "Cash advance as well?" he insisted and smiled when she agreed readily, counting out the credits from her pouch into his sweating hands. This was more cash than he had ever seen before. He stuffed it into his pockets before it vanished. Maybe things were starting to turn around.

The ship she had arranged for him was a monster, far larger than anything he had ever seen before. He was astounded by the accommodations of his quarters once he was aboard. Not only was there a decent Earth toilet and bed, but a full complement of liquor and delicacies that he had not seen in years.

"I . . . trust . . . that . . . every . . . thing . . . is . . . agreeable?" the slow-moving, vaguely reptilian steward groaned slowly through its blow-hole. Sam had unpacked his bag and settled on the soft bed in the time the alien took to state the brief sentence. If that was the speed of speech for the crew this would be a long trip, no matter how "local" Ahbbbb said that it was.

"Yes, is fine," he responded with a smile and opened his star guide while the translator ever so slowly croaked out his words to the waiting steward. In the distance he heard the great hatches close to signal their departure. But Sam didn't care. He had finally gotten the best of Ahbbbb. There was no way she was going to

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screw him this time. This was one fine suite indeed.

Now, he wondered as he turned the pages of the guide, where the hell was this Andromeda place, anyway? ■

IN TIMES TO COME

Our November cover is a real dazzler by Bob Eggleton, aptly illustrating Gregory Benford's lead novelette, "A Worm in the Well." Exactly what the title means will be clear enough once you've read it; but for now I'll say only that the "worm" is something very rare, exotic, and valuable, and the well is an exceedingly deep and dangerous one. So much so that most people would consider the worm, however valuable, hopelessly out of reach. But if you *need* something badly enough, your appraisal of such things can change....

Robert M. Zubrin, one of *Analog*'s favorite purveyors of ideas, has another fact article on "The Martian Frontier." As you'd expect, it's partly about how we can get there, but no less important are its observations on why we should.

And, of course, we'll have a variety of other fiction, including stories by F. Alexander Brejcha and Wil McCarthy—and Part 2 of Lois McMaster Bujold's *Cetaganda*.

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BIOLOG Jay Kay Klein

At a first visit to this magazine, a young Isaac Asimov expected to see a staff of dozens. He was astounded to find engineer and SF writer John Campbell did it all with the help of one woman. The editor said Kay Tarrant turned out the magazine while he had the fun of reading stories and talking to the writers.

Tina Lee does the job of turning out the magazine today, while physicist and SF writer Stanley Schmidt reads the stories and works out kinks with the writers. An intern with *Analog*'s sister magazine *Asimov's* while a journalism student at New York University, Tina then became a full-time editorial assistant for both magazines.

As a child, she read a great deal, later joining creative writing classes. As for writing SF, she has had a chance to meet many *Analog* contributors and is awed by their grasp of the sciences, coupled with the intricate thought processes it takes to work out a valid *Analog* hard-science story. She thinks there are too many ways for a non-science person to have a plot come unraveled by a wrong fact or misunderstood scientific process.

Born in New York City of parents from a village near Canton, China, Tina speaks a local dialect at home, where the family sometimes calls her "eldest daughter." She studied French in high school, Mandarin at NYU. Her mother was a textile designer before taking over a Chinese restaurant she still runs in West Orange, NJ. Starting at age three, Tina did modeling for magazine and fashion shows for several years until this started interfering with schoolwork.

Tina might still be taken for a model, since she exhibits the dress and grooming of cultivated women most usually found in New York and Paris, and increasingly now in other great cities. During visits to China, she felt herself an object of curiosity since she is much taller and fairer than the local inhabitants. She has continued meeting people of other cultures in England, France, Italy, Switzerland, Holland, and the Caribbean. Her husband is a financial planner and a lawyer, and they are raising

Photo by Victor Ngai

Tina Lee

their two-year-old daughter to be bilingual in English and Chinese.

Being exposed to the thought processes imposed by another language and immersion in a pair of differing cultures has made Tina receptive to the

(Continued on page 161)

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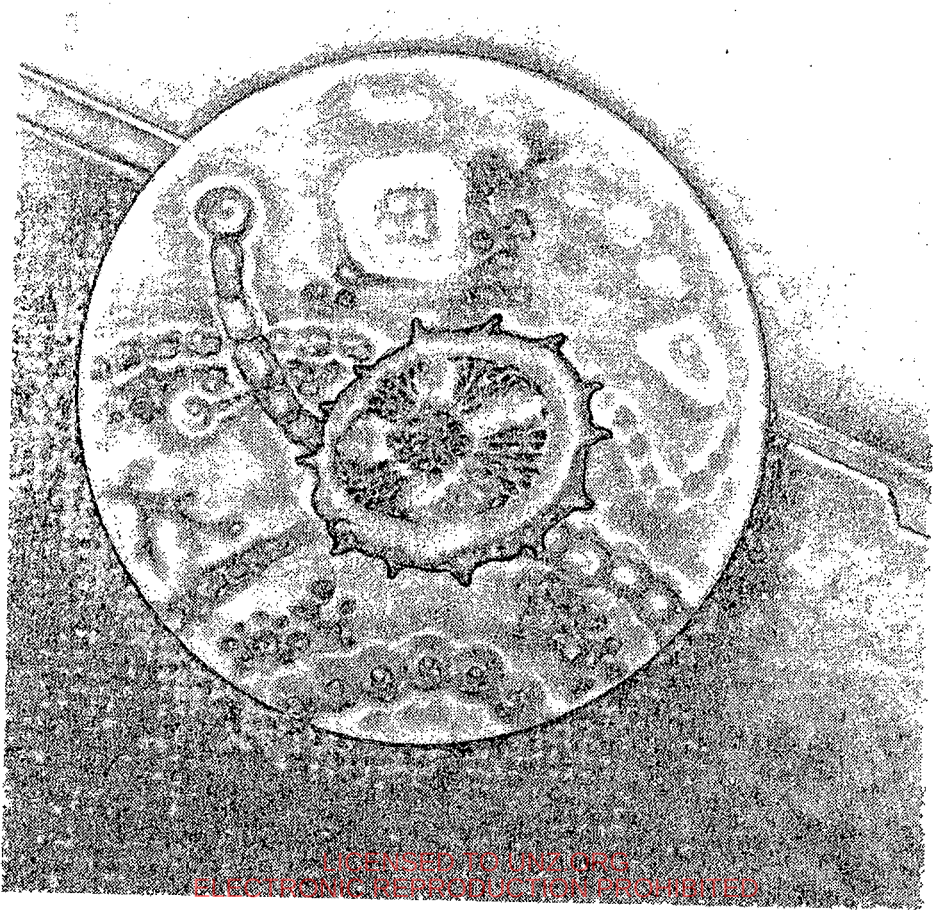
Robert R. Chase

THE WELLNESS PLAGUE

There are two main ways to deal with an alien environment, and one of them is clearly superior in the long run. But that one comes with a side effect that's harder to accept. . . .

Illustration by Dell Harris



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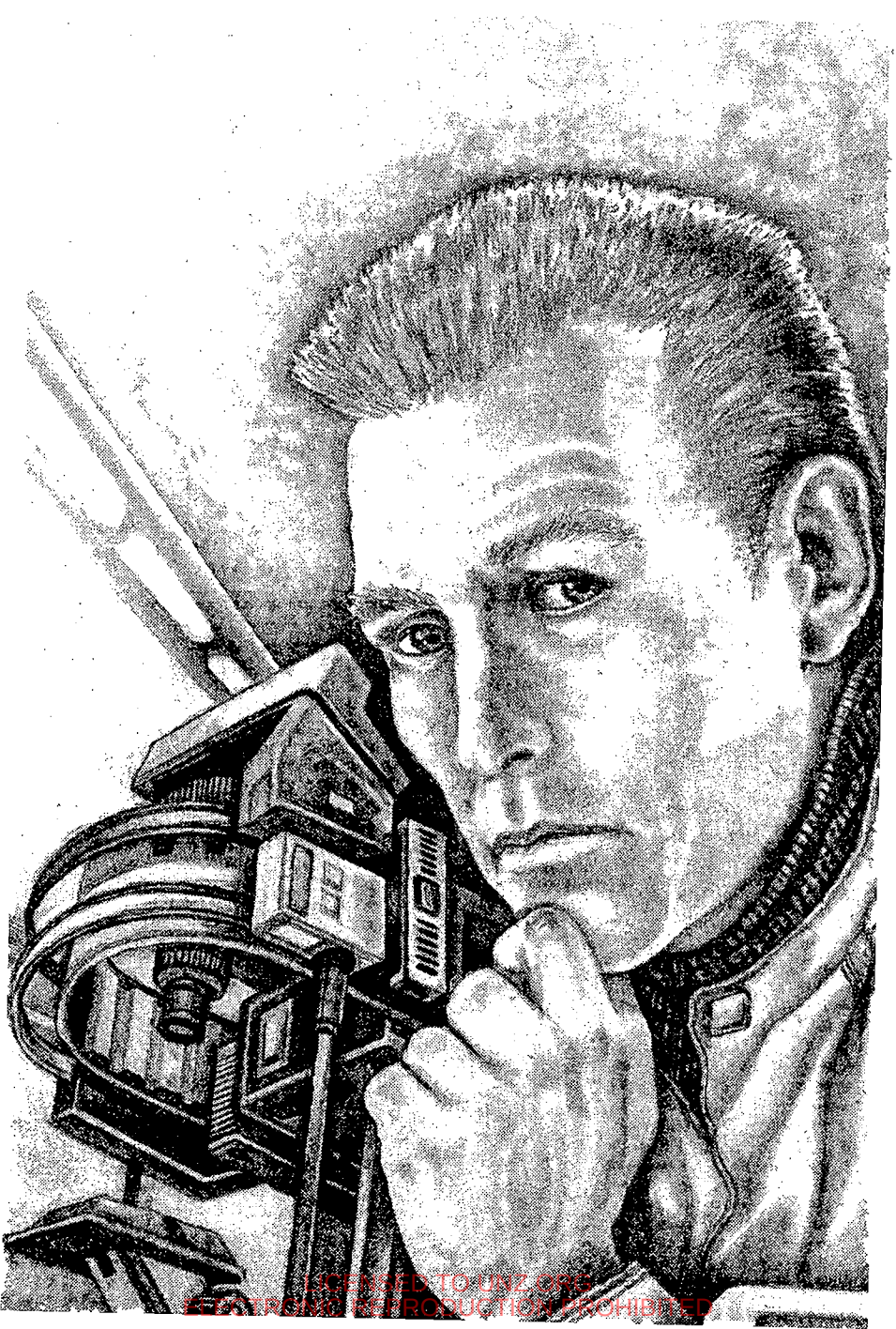

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I.

"Why are you traveling to Far Edge?" the pilot asked.

Reynolds Morrill-Landers kept his eyes glued to the window, unable to turn away from the empty immensity outside. Wind rushed across the Sunbird's metal skin, which seemed no thicker than foil. With each gust of wind, with each course adjustment, the whole craft creaked and groaned in protest. Above, wispy clouds of ice crystals broke the sunlight into muted rainbows. Below them lay layer after layer of clouds. You could look down through the gaps, sometimes all the way down to the lush darkness of the world jungle that was the floor of Skylandia.

Fear of heights, he told himself, was an absurd emotion on a world where humans could live only on mountaintops. In the past, though, he had always had solid rock beneath his feet. Now there were only struts and metal skin and absurdly long glider wings, their dark topsides drinking in sunlight and converting it to electricity for the lifting fans. An experimental craft whose pilot was a girl no older than he had been when he had been first admitted to the College of Apollo, who could fly legally only because her craft did not exist in the registry of vessels requiring certification.

Belatedly, he realized that Regan Lee was still waiting for his answer.

"Research," he said. "I'm a medical master. The local practitioner has been sending some interesting reports to the College of Apollo in the Terraces. I'm here to see what I can make of them."

"Really?" Regan asked. "The people of Far Edge seem pretty healthy to me."

"Well, that's the problem," Rey said, almost apologetically. "In some ways they appear to be too healthy." She looked at him skeptically. "Do you have allergies?" he asked.

Her laugh was high-pitched and musical. "Who doesn't? That's the reason I learned to fly. Up here I'm not battling headaches or fighting for breath."

"Right," Rey agreed. "Most of our communicable diseases burned up with the rest of Earth, and our population densities have been low enough to keep new ones from generating. But ever since our great grandparents landed on Far Edge, we have been plagued by allergies. Despite the cordons surrounding the colonies, dust and pollens still blow up from the jungle below. Since we never evolved with these, it's no wonder we react to them. About twenty deaths a year can be traced back to some sort of allergic reaction. Even without the deaths, there are hundreds of thousands of man-hours lost.

"Except on Far Edge. Since it has the lowest elevation of any of the colonies, it should have the worst allergy problems. The records show that it did when it was first settled. Then, gradually, the incidences decline. The local practitioner eventually recognized what was happening and mentioned it as an aside in her reports. I queried her a few months ago, but she has no idea of the cause. I thought that if I could find out, it would make

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a good enough paper for my doctorate."

Not to mention that if he were able to formulate a general treatment based upon what he discovered, he would probably be a moderately rich man for the rest of his life.

The craft lurched suddenly. Rey clenched the armrests, wondering if the struts were screeching in a different key. Regan was tacking across contrary wind streams, fighting the seasonal easterlies which made Far Edge inaccessible to cargo zeppelins. Noting his concern, Regan said "Just a little clear air turbulence. If you had your visor on, it wouldn't take you by surprise."

Her own visor masked the upper half of her face. A confusion of bright yellow lines played across its inner surface, totally obscuring her eyes. His visor was hooked onto the arm rest. He had worn it for the first ten minutes of the flight. Air currents had been given form and color. With it, he could tell their extent, their speed and direction relative to the *Sunbird*. Thermals boiled upwards, suddenly visible elevators which might carry them most of the way to their destination with hardly a touch of the craft's solar-powered fans. At the touch of a button, while the left side of the visor continued to display the winds in whatever direction you were looking, the right side would provide a satellite weather map of the pressure gradients and frontal systems in their flight path.

Information overload. Without Regan's training, there was just too much data displayed for him to comprehend it all. More than that, it obscured what he could appreciate. When he took it off, he saw mountain peaks near the horizon which seemed to be floating on a sea of clouds. The Sun fell behind them. High in the gathering dusk, the bright moving dot that was the Ark appeared orbiting outside Skylandia's shadow, a reminder of all their ancestors had lost, a promise of what they might one day achieve again.

He had never seen much of the sky while studying at the College of Apollo. Studies forced you into a sort of tunnel vision during the day. At night, the bulk of the main mountain blocked out half the sky, while path lighting washed out much of the rest. It was as if the Terraces had decided to ignore as much of the planet as possible.

If so, they had made an unpardonable mistake. Hanging in the middle of the sky, Rey could almost wish himself a Naturaler, sustaining himself solely on the untouched beauty of the planet.

"Do you often fly out this far?" he asked, feeling a twinge of envy.

"Not very, but you have to remember that *Sunbird* is still in its testing phase," Regan answered. "Last month was the first time I've ever flown to Far Edge. Picked up a cargo of kids going to the Old Earth Days Ball at the Terraces. Their parents didn't have the money to rent or the clout to commandeer a VTOL. Had a hold full of Rhett Butlers and Scarlet O'Haras in absurd dresses."

Perhaps it was his imagination, but there seemed to be a trace of wist-

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fulness in her voice, as if she could see herself in something less practical than aviator's overalls.

She spotted Far Edge an hour later. While she talked to ground control about wind speeds, he peered out his window, vainly searching for their destination. From the maps he had studied, he remembered that there should be a central crater serving as a reservoir. Below that would be two smaller craters, partially filled in so that they could grow rice. The mine entrances would probably not be visible. On the other hand, he should be able to see the orange groves which clung to the south side of the mountain. In the Terraces, only the rich could afford the arboretum-grown oranges.

"Over there," Regan said, pointing. "About four o'clock."

Twin handgrips controlled wing attitude. She twisted them now and the wings mimicked her movements, spilling air. *Sunbird* banked, losing altitude. Suddenly, a wedge of land appeared below them which seemed to plunge through the cloud deck like an ancient ocean ship through high seas. Regan brought the craft around in order to land into the wind. Unfortunately, that also meant heading straight over the cliff, trying to land in an area designed for VTOLs and zeppelin moorings.

Light dimmed suddenly as they fell into the clouds. Rey strained for a glimpse of the ground. It appeared suddenly, less than four meters below them. Just ahead, the earth dropped away to jagged nothingness.

Regan pulled on the grips and twisted. Obediently, the wings tilted to vertical, cupping the wind. Forward motion stopped abruptly. The *Sunbird* dropped like an elevator whose cable had been cut. Lifting fans roared to life. Sudden deceleration pressed Rey down into his seat.

The pressure eased, the noise of the fans decreased and then whispered away into silence. To his surprise, Rey realized that they were on the ground. They were not going to crash after all.

Regan was grinning at him.

"What would have happened if we had missed the pad?" he asked, feeling obscurely defensive.

"I would have brought us around for another approach," she answered.

"So we were never in any real danger."

She cocked her head, as if considering this thought for the first time. "Well, I don't suppose I would go that far. Wind gusts along the cliff face tend to be strong and erratic. I would hate to have caught a wing on the rocks."

"Right," he said.

Following Regan's example, Rey pulled the latch at his side. The wall fell outward to the ground, becoming a makeshift gangway. He took two unsteady steps and hopped to the ground. A warm fog was blowing up from the cliff edge. More than once, older acquaintances in the Terraces had described the odor of the world jungle as an affluvium of rottenness, as if the entire world were decaying. This was not at all like that. It was a smell of openness, accented by traces

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of spice and mint.

Rey reached out to steady himself on the *Sunbird*, his sense of balance deceived by the gusting fog. His nasal passages were already beginning to close off. He reached for the box of antihistamines he kept in his shirt pocket.

Figures loomed out of the dimness. Rey turned on them quickly. Luckily, nobody could see the flush of embarrassment which immediately followed. Even in the gloom, he could see that none of them had the starburst manes of the White People. If the White People actually existed. It had been nearly five years since the Bainbridge child had been stolen and a Changeling left in his place. Efforts to retrieve the child had been thwarted by the planet itself as much as by his captors, who had come to be known as the White People. Their existence was officially denied. Rumor and a rapidly growing folklore had mushroomed to fill the gaps.

Regan had already opened the cargo hold and was lifting out packages to the ground crew. Rey went to help her. As he placed the last of the boxes onto a hand trolley which, like the people, seemed to have just materialized out of the mist, he became aware of someone standing nearby, examining him.

"Dr. Morrill-Landers?" A woman's alto voice, low and hoarse. The way she pronounced his name made it sound like "mer-*lan*ders." So much, he thought, for all the families struggling to preserve the old names and lineages. Human laziness warred and won against the ever-increasing number of syllables.

"Not yet," he said, straightening and offering his hand. "Medical Master only. You must be Practitioner Mazio-Carr."

She shook his hand absently. Martina Mazio-Carr was a big-boned woman, with hands as rough as her voice. "I asked for a full doctor. Can you tell me why they sent you?"

The irritation was not directed at him, Rey realized, but at the bureaucracy of the Terraces. "I have no idea," he said mildly. "The fact is, though, that nobody sent me. I came to do research."

"Research?" The concept seemed to astound her. "Much time you will have for that. There are the sick to be taken care of."

Rey located his duffel bag and shouldered it. "Really? I was told people here were unusually healthy on Far Edge."

"Were you indeed?" she asked. "Well, there may be something to that. I'm not talking about people. I'm talking about the livestock."

II.

Mazio-Carr got him installed in the Murchisons', a rambling building, or series of buildings, which had originally been a Freehold but now served as a boarding house for colony singles and young families. It was half-buried in the side of the central crater for protection from the storms which blew up from the jungle depths. High winds could do tremendous damage at one and a half standard atmospheres. Rey was shown to a corner room that was little more than a bed

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and a small desk with a horizontal slit window above each.

During dinner that night, he met his fellow roomers. Juanita Buergher-Murchison owned the house and ran it with the assistance of her daughter, Katarina, and her teenaged son, O'Donnel. Don was a good-looking boy with the reputation of being something of a Romeo. Dinner table conversation had it that he and Andrea Calley-Li, the governor's youngest daughter, had been a hot item during Old Earth Days. But despite all the kidding, Don appeared to be friendly and hard-working, if not overly bright.

When not insisting that he take overly-generous portions of her cooking, Juanita wanted to know whether any more children had been kidnapped by the White People. Her eyes, as she asked the question, kept straying to her own children.

"None," Rey assured her. "There are always rumors, but they are never confirmed."

"Well, they wouldn't be," said a burly man with a mustache seated across from Rey. He introduced himself as Garrard Ryn-Rosenberger, a mechanic in charge of the robots which continually sanitized the cordon surrounding Far Edge. "After all, the government would just use the Public Safety laws to suppress that sort of news."

Rey chewed a slice of lamb as he considered that, suddenly acutely aware that he had paid almost no attention to politics for the past three years. "I don't think they could do that successfully," he said after a moment. "Oh, they might try, but from what I've seen, the government really isn't all that efficient. If more children were kidnapped, there would be a hue and cry that they would never be able to quiet."

They seemed to accept that, yet for the rest of the evening Rey was aware that behind their questions was a lingering doubt that the satellite news feeds were telling them the whole story. Chandler and Linda Karatnycky-Sullum were newlyweds, both working two jobs in hopes of putting enough money together to establish their own freehold. Linda wanted to hear all about the Naturalers. Rey amused the whole table by relating how one had become deathly ill after sneaking though the cordon surrounding the Terraces to gorge on the fruits of a native bush. The Alienist poets had been especially harsh, comparing this to a reversion to bestiality.

"But, of course, the Alienists suffer from enough of their own contradictions," Rey added. "Their incessant whining about how we can never be at home on this world is bad enough, even without declamations to the effect that the only completely free act is suicide."

Chandler was more interested in the Technics. He confided to Rey that he had once dreamed of joining the Astronaut Corps, that he had wanted to help maintain the Ark for the day when it could be used to explore their solar system and, perhaps, even reclaim its heritage as a starship.

"From what I hear, the Technics have been coming up with grand plans to make the rest of the planet

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habitable," he said.

Rey nodded cautiously. "There was some discussion of nudging an asteroid out of orbit and directing it so that it would impact in an uninhabited portion of the planet, the idea being that the explosion would blow off enough of the atmosphere to make the surface pressure approximately one atmosphere."

"Then we wouldn't be confined to mountain peaks any more," Chandler said, his eyes shining.

"Quite so," Rey agreed. "However, the Naturalers produced calculations demonstrating that any such impact would raise the temperature of the atmosphere by ten degrees. Only temporarily, to be sure, but long enough to destroy most of the oxygen-producing biosphere at the lower levels. Not to mention the fact that such an abrupt lowering of the atmospheric pressure would make our mountain colonies completely uninhabitable."

He slept that night, listening to the wind whistling about the eaves. He dreamt that he had been taken to the most secret place on the planet, a Freehold basement where the Changeling, which had been exchanged for the Bainbridge boy, was kept. It talked of Alienists and Naturalers and Technics, its approximately human face contorted with an almost pathetic earnestness. Rey listened intently, but when he woke, all he could remember was a low growling, like that of a sick dog.

Martina's practice was as varied as it was large. The first assignment she gave Rey was the thrice weekly first-aid course. It was conducted in the school before classes started in the morning. There were usually between five and twelve in the course. At first, Rey thought he had been given this task because Martina considered it drudgery and did not trust him with anything more complicated. He soon realized that it might be the most important part of the practice. The colonists on Far Edge were spread too far apart for even the two of them to be able to provide timely medical care in emergencies. So he taught everything from the Heimlich maneuver to CPR to setting broken bones to delivering babies.

Afterwards, there were patients. A large number of these had "women's problems": fertility had been a major concern since humanity had come to Skylandia, and the lack of a major satellite had distressed the menstrual cycles of every generation of women since then. There were drugs which could be used to regularize the cycles, and in households which included several women of child-bearing age, having only one of them on drugs was often enough to regularize them all by pheromone entraining.

Marty's diagnoses and treatments clearly went beyond the guidelines established for practitioners, and were arguably even illegal. That they were necessary was beyond argument. The nearest actual doctor was in Jump Off; the nearest hospital, fifty kilometers beyond that in New Geneva. During the winter, all that distance was against the prevailing winds.

As Marty had warned him, a large proportion of his time was devoted to

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livestock problems. Sheep especially drew bloodbird attacks. Marty maintained two marrow machines with no other use than to continually produce fresh sheep blood to be used for transfusions. At least twice a week, Rey would find himself ministering to an exsanguinated sheep, its dirty fleece stained red at the punctures. Sometimes the bloodbird would still be attached, its ten-centimeter beak buried in the sheep's flesh, its stomach distended as it gorged. Removing the bird was tricky. It could be killed easily enough, but the backward pointing barbs made it impossible to pull out without tearing a sizable chunk of flesh along with it.

Marty showed him a trick of breaking a bag of blood from the marrow machines over the beak at its entry to the wound. The beak closed in apparent disgust, disengaging most of the barbs. With one swift, fluid motion, Marty pulled out the beak and snapped the creature's neck.

"Why does that work?" Rey asked.

Marty shrugged. "They don't seem to like what comes out of the machines." Her manner said that it was a useless question as long as it was effective.

"They're stupid beasts," she added. "If they had any brains, they would have realized a long time ago that we're no good for them." Except, of course, that a million years of evolution had taught the bloodbirds that anything of a certain size which moved was almost certainly good for them. They flew too high to be disturbed by alien scents. Human beings were recent interlopers; it would take the native fauna a while yet, perhaps aided by adolescents with homemade lasers, to associate this set of smells and colors with non-nourishing amino acids.

One week when he had seen more sheep than people, Rey found himself staring at his office data screen, wondering just how many of the creatures there could possibly be on Far Edge. The morning had been spent treating part of a flock owned by Freeholder Paabo Bhagwati. He connected with the municipal registry and had it display the extent of the Freehold. Another query brought up the size of Bhagwati's flocks as of the last quarterly reporting period. Rey frowned at the number, surprised that it was so large. On a hunch, he called up the carrying capacity ratio established by the Ministry of Agriculture and plugged in the figures.

Marty had come back from lunch and was standing behind him, regarding his screen intently.

"Something's wrong with the data base," he explained. "Bhagwati claims to have almost twice as many sheep as his farm will support."

"Maybe he's inflated his figures to impress the bankers," Martina suggested. She sounded distinctly unhappy. "As a general rule, the greater your collateral, the better your loan terms."

Rey chewed his lip, thinking about that. "No," he decided. "Any advantage would be more than offset by his higher tax rate. Besides, any bank would run the same sort of check, and would determine that he was overgrazing his land, which would

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make him a bad credit risk, in addition to being illegal per se."

The phone chimed. An eleven-year-old who had been playing outside the fence near the airport cliffs had fallen and suffered a compound fracture. Rey strapped a new filter over his nose and mouth and jumped into the office's dragonfly flitter. It was the end of the day before he returned to the clinic. A VTOL stood on the landing pad across from the entrance. Rey recognized the markings of the Bhagwati Freehold. As he stepped out of the dragonfly, he saw Paabo Bhagwati walking toward him.

"Not another bloodbird attack?" Rey groaned, feeling exhausted.

Bhagwati permitted himself a miniscule smile. "No. I am not in need of your professional services. Rather, it appears that I am still in your debt. I have heard that you are perplexed about certain aspects of my freehold."

Marty was standing in the doorway of the clinic, her face unreadable.

"I wasn't meaning to pry—" Rey began.

Bhagwati shook his head. "Of course not. It is just that your intelligence is not confined to your work. Come with me. I shall make things clear."

Rey glanced quickly at Marty. She nodded. He climbed into the cockpit of the VTOL and sat next to Bhagwati. It was a large craft, smaller only than the lumbering cargo carriers which were the backbone of trade among the colonies. Its hold smelled of hay and sheep and dirt. Bhagwati touched the controls and it surged up fifty meters, where it caught the easterlies. It seemed to Rey that Bhagwati, rather than pilot the craft, simply let the winds blow the VTOL across Far Edge to his freehold. He set it down in a pasture close to the cordon, an area Rey had never seen before.

He handed Rey paper booties to protect his shoes. "It is not really dangerous if you just walk through," he explained apologetically, "but people do tend to get nervous."

Rey tied the string above his ankles, then followed Bhagwati out of the VTOL. The freeholder headed down the slope and stepped without hesitation into the cordon.

Rey winced and forced himself to follow. He stepped carefully over the fluorescent orange plastic tubing which extended all along the cordon's higher, inner edge. It was Ryn-Rosenberger's job to make sure that the poison flowed at an even rate through that tubing, that it soaked through to the bedrock and extended the mandatory fifty meters width. This had caused problems in some colonies. Stripping the slopes bare of vegetation increased erosion, sometimes drastically. The cordon, which prevented the encroachment of native fauna, would seem to become a noose pulling ever tighter.

That was not the case here, however. The land sloped gently, not to a cliff as on the airport side, but to a ridge. Rey moved quickly, telling himself that the poison was dangerous to humans only in accumulated dosages. Even if the booties were to tear, what adhered to his soles should not be unsafe. As long as he did not fall and cut himself. . . .

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The cordon gave way raggedly to groucuh, which extended itself like grasping fingers into the surrounding sterility. Rey frowned and bent down to pull up a clump. Groucuh was only a contraction of "ground cover," an all-purpose term for the smaller sort of natural flora; that is, what should be easily killed by the cordon poisons. Like most of his fellow humans, Rey had little idea what it was like. The one thing he did know, however, was that it was substantially different from Terrestrial grasses and grains.

In his hand he held a coiled mass of vegetation, in more shades of yellow and purple than he could count. It seemed to grow like an insane slinky toy. As far as he knew, it was like nothing which came from Earth.

Yet, inextricably tangled in this mass, were grass blades identical to those which grew in the inner quadrangle of the College of Apollo. They should not be able to grow in the same soils. They certainly should not be so intertwined as, say, lichen.

Bhagwati was waiting for him patiently. Rey dropped the clump, filing it away as a mystery to be examined if he ever had time.

Ahead of them rose what was, at this distance, clearly an artificial embankment. It was high enough to shield whatever was behind it from the view of anyone walking the cordon. Hearing the almost soporific bleating punctuated by a few barks, Rey realized he had no need to see what lay beyond.

Nonetheless, they both crested the rise and paused while Rey assessed the view. The ridge widened to the size of a small meadow. Low fences marked the beginning of the steep incline. A dog ran along one of the fences, yapping excitedly at sheep careless enough to wander too close.

"How many are there?" Rey asked.

"About five hundred in this meadow," Bhagwati said. "Nearly four hundred each in the two beyond. You can't see them from here because they are about fifty meters lower."

Rey looked down at his feet. The grass-groucuh was thick and springy, coiling up above his ankles. "It's amazing that the groucuh doesn't just crowd out the grass. And that you can feed this many sheep on what grass manages to survive."

Naturalers to the contrary, the first generation had conclusively demonstrated that Skylandia's biochemistry was too different for it to be nourishing to anything which had evolved on Earth.

Bhagwati shrugged. "I did not have nukes," he said, almost apologetically. "At first, I feared my incomplete clearing would doom my efforts. As you see, they did not. I am told the fleece of these animals makes wool cloth especially prized, even on the Terraces."

Rey looked around at the meadow and beyond. It was such a clear day that he would have been able to see all the way down to the world jungle, had advancing night not already cloaked it in shadow. On the far horizon, a line of clouds was growing that looked as dark and solid as the planet's crust.

"Why?"

It was really two questions. Bhag-

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wati answered the first.

"Far Edge was cleared because there were getting to be too many people in the other colonies. The Terraces took nearly a decade to establish the colony, pleading lack of resources. By the time it was declared safe for habitation, the number of those who had signed up for emigration had nearly doubled. It seemed good politics to accommodate all. Only, the size of the plots was then too small for economic viability. Many failed, like the Murchisons. Most others, like the Karatnycky-Sullums, have no realistic chance of success.

"I did not want to fail. I saw this land, just beyond the cordon. I thought, if I had just a little more, I would be able to survive. So I planted grasses, and moved sheep across the cordon. Some went hungry, and I was very afraid. But then others started to thrive, and soon the whole herd was doing well."

"Nobody has noticed this from the air?" Rey asked.

"The airfield is at the opposite end of Far Edge," Bhagwati answered, "and much of the time fog covers the land."

"But the satellite photographs!" Rey insisted.

Bhagwati shrugged. "They do not look so different from the surrounding lands. In the Terraces, where they study those pictures, they know nothing can lie out here, so they do not look closely."

"Why are you showing me this?" Rey asked. He was acutely conscious that there were only the two of them out there, that only one other person knew where he was. He knew enough to ruin Bhagwati, both legally and financially. If he were to be pushed over the side, he would probably never be found.

Bhagwati nodded, as if aware of his thoughts. He stood apart from Rey, hands down at his side, as if trying to demonstrate his harmlessness.

"You were asking intelligent questions," Bhagwati said. "If I did not answer them, you might raise them with your friends on the Terraces. The government might feel forced to do something were this brought to its attention."

"They can run the numbers as well as I can," Rey objected.

"They have chosen not to," Bhagwati answered. "Or if they have, they have dismissed the result as business puffery."

"It would have been much simpler if you had reported only your herds within the cordon," Rey said, exasperation giving an edge to his voice.

"That would have been a lie," Bhagwati said simply. "I owe the taxes on my true wealth. Anything else would cheat my neighbors and my friends. Also, I think that at some point, someone would wonder how I could maintain my cash flow from such a small resource base. I have broken one law. That is enough."

The wind freshened. Even through his allergy mask, it seemed to bring up scents from the jungle far below, odors at once disturbing and enticing.

Bhagwati waited patiently.

"All right," Rey said at last. "I am not going to turn you in to the proctos." *And that may be the end of any*

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hope of ever obtaining a doctorate, if they ever catch you and decide that I was a co-conspirator.

"As far as I can tell, what you are doing has resulted in no damage to the agriculture or the health of the colony. I suppose if this violation is considered serious, it is a matter for Mr. Ryn-Rosenberger and his superiors."

Bhagwati flashed a smile as dazzling as the setting sun. "Thank you," he said, bobbing his head slightly. "Let us go back now. I believe a storm is coming."

III.

The storm swept over Far Edge during the night. Lying in his bed, it seemed to Rey that the whole building swayed under the hammer blows of the wind. The next morning he was awakened by the sound of all the VTOLs in Far Edge chopping the sky in a search pattern. O'Donnel Buergher-Murchison and four friends had flown out to a mountain called the Claw for a day of hunting bloodbirds and rock climbing. Their VTOL had not returned before the storm's onset. There were no distress calls.

O'Donnel's mother maintained a ghastly cheerfulness which Rey found more distressing than hysterics. She was sure the boy and his companions had suffered only a minor mishap, and that they would be found in a matter of hours. As the hours became a day, two days, and then a week, Rey felt the tension building to a breaking point.

Marty agreed. "None of the families are in what you'd call good shape, but Juanita is probably under the most strain. First her husband dies, then they lose all their freehold lands and manage to retain their home only by turning it into a boarding house. Nothing against Katarina, but all her mother's hopes were on that boy. I don't know how she'd be able to live with his loss."

Given the contrary winds, there was little the other colonies could do to help with the search. Not that they seemed over-inclined to be of aid. There was almost a querulousness to the messages from the Terraces, a sense that the unauthorized flight beyond the cordon was of more concern than the possible loss of lives.

First-aid classes were suspended so that more of the colonists could aid in the search. Rey discovered to his surprise that he had free time. He used some of it to go over the notes he had made on allergies.

Even in the supposedly air-cleaned homes of the freeholders, his head throbbed and his eyes watered. Often, the families he visited would discover to their surprise that the filters had not been working for a year or more. It did not matter to them. They showed no allergic response to their environment.

Or at least most of them did not. Babies did. All babies, until about the age of three. It made no sense. Usually a child would benefit from his mother's immune response transferred through breast milk. Here, you could almost imagine that the mother was somehow suppressing a natural immunity.

If something like that was the case,

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where did the immunity come from? It did not seem to have anything to do with the genetic make-up of the colonists. They had come in nearly equal mix from most of the then-established colonies, usually, though not always, from the lower end of the economic scale. The immunity had developed gradually. In retrospect, you noticed that fewer and fewer antihistamines were used. Now, only visitors, newcomers like himself, and the newborns needed medication.

It was an acquired immunity. Babies might require three years; adults seemed to acquire it in a matter of months. So how was it acquired? What was different about Far Edge? First answer: it was lower in elevation and consequently warmer than any other colony. Problem: none of the literature on allergies suggested any possible correlation with air pressure or temperature. If anything, there should be an inverse correlation. There should be more dust and pollen at the lower levels. If the flora of the world jungle produced pollen. It was astonishing how little was known about the natural lifeforms on this planet.

What about diet? Research, and his own experience, disclosed that Edgers ate pretty much the same stuff as other colonists. They had a greater amount of exotics, like oranges and grapefruit, because they were locally grown. And, as he had noticed since his arrival, they tended to eat a lot. He had put that down to the difference between their active, outdoor lives and the sedentary, enclosed life with which he had been familiar in the Terraces. If his figures could be believed, however, adults on Far Edge consumed up to 50 percent more than settlers on similar frontier colonies.

Feed a cold, starve a fever, Ben Franklin had said, hundreds of years ago and light-years away. Only allergies were not colds.

Regan Lee had flown the *Sunbird*, specially modified with new search gear, back to Far Edge to join in the search. Rey was still thinking about the allergy problem when his communicator chimed with a priority message: Regan had spotted wreckage near the base of a ridgeline. It was almost certainly the VTOL flown by O'Donnel and his friends.

IV.

Lopez Vega snapped the cable onto Rey's harness and tugged hard to make sure it was secure. Rey looked doubtful.

"We use these cables for lifting everything from livestock to heavy machinery," Lopez said, shouting to make himself heard over the roar of the VTOL's engines. "You don't have to worry about that.

"Keep an eye on the time, though. Ting Lim can't hold us here for more than half an hour. If you need more than that, you'll have to unhook and let the Canberra Freehold VTOL take you back. It's on its way now."

Rey nodded to show he understood. As clean and safe and simple as it was to obtain hydrogen from water, it was still not as energy-intensive a fuel as Earth's petrochemicals had been. Having come this far, the time they could spend on station was

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strictly limited.

"Ready, Doc?" Ting-Lim Chan's voice came over Rey's earphones. As pilot, he would have to hold the VTOL steady as the combination of his reflexes and electronics allowed. Breezes were light. On the other hand, the higher air pressure gave an unexpected force to even low wind velocities. Ting-Lim was trying something never done before.

"Ready," Rey said, his mouth so dry the word came out as a croak. Then, because he feared he might freeze if he did not move immediately, he stepped to the cargo door, leaned out, and kicked off.

The first five meters were almost free-fall. "Want to get you beyond the worst of the prop wash," Ting-Lim had explained. His descent slowed abruptly. The world rotated around him, back and forth in 270 degree arcs. Rey closed his eyes, waiting for his rotation to damp out. When he opened them, he was just above the trees.

There are no trees on Skylandia. That was what they taught you in school. *Real trees, Earth trees, have xylem and phloem, bark and leaves or needles. Local flora have none of these.* But there were organisms drawing water and nutrition from the soil, organisms extending sunlight-absorbing surfaces from strengthened central stalks many times longer than a man is tall. And since that was the common, if not the scientific, definition of a tree, all the school definitions went for naught.

The ridge slanted away below him, a canted field of pinkish-white puffballs. His feet brushed the upper branches, seeming to sink into a huge ball of cotton.

"Slowly," he said, hoping this throat mike was working. "I don't want to get tangled."

"Roger that."

He moved branches aside as they came within reach. What had looked like a vine coiled around one branch vanished in a sudden flurry of sinuous motion. Startled, Rey let go of a branch, which whipped away his breathing filter.

The branches thinned as he descended, the leaves changing from white to greenish-yellow to nearly black. A dimly-lit dome seemed to open around him. The VTOL motors sounded very far away.

In school, he had watched a film titled *Memories of Earth*. Children in a field, playing with a dead plant called a dandelion, blowing its seeds to the wind. The tree seemed to have a similar structure. Branches extended from the top of a central stalk in all directions, forming a sphere.

"Can you see anything?" Lopez's voice was unexpectedly loud in Rey's earphones.

"Not yet." Rey looked around, squinting at shadowy, unidentified forms. Sunlight poked small holes in the canopy. There was an intermittent rustling, which might have been the wind.

"There it is!" he said. "Right between my legs. No wonder I couldn't see it at first. Great job, Ting-Lim."

"Any movement?" Lopez asked.

"No," Rey said. On the other hand, there were no bodies visible, either.

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The VTOL had apparently crashed through the canopy and broken several branches, which slowed its fall before hitting a limb strong enough to stop it.

"It's caught in the cleft between some of the main limbs. One of the rotors came off in the crash. The door to the cargo bay must have popped off at the same time. The whole frame is leaning over. Getting in is going to be tricky."

Rey stopped his descent when he was even with the open cargo bay. The upper edge of the craft extended about a meter beyond the floor.

"I'm going to try to swing in." Rey pumped the cable back and forth. His arc carried him into the cargo bay. After two unsuccessful attempts, his scrabbling hands grabbed one of the ring mounts used for lines to secure whatever was being transported. His feet found the floor. Very carefully, he unhooked the cable from his harness and attached it to the ring mount.

"The cargo bay is empty," he reported. "I'm going forward to check the cockpit."

As he moved forward, the VTOL groaned and tilted in response to his shifting weight. Rey held his breath, wondering how far it was to the ground. Nothing happened. After a minute, he began to edge forward more cautiously.

A figure sat slumped over in the pilot's chair. Small food cartons, the type that made up part of any VTOL's emergency kit, formed a pile in the corner. Already knowing what he would find, Rey felt for a pulse. He sighed as he let the wrist fall.

"Belkom Michaels-Nye. There are splints on both legs. Dead a little more than a day, as far as I can tell. We just missed him."

"Anyone else there?" Lopez asked.

"No." Rectangles on the wall showed where the emergency kits had been. At least one other member of the party had survived, had done his or her best for Belkom, and then . . . what? Climbed down the trunk to attempt to walk back to Far Edge? Stupid, stupid, stupid! "Stay with your craft" in case of accident was drilled into you from the time you could walk. It had been hard enough to spot the VTOL. Individuals would be invisible under the jungle canopy.

"Excuse me." Ting-Lim's voice. "I can hold here for only about ten more minutes."

"Right," Rey acknowledged. He reached around to detach a body bag from his backpack. "We'll be right up."

He sat across from the open cargo door on the flight back to Far Edge. The jungle skimmed by beneath them. O'Donnel and his other three friends might be anywhere below. It was even conceivable that they were still alive.

There was nothing more anyone could do except arrange for the memorial service.

Two nights later there was another storm. Paabo Bhagwati awoke, listened to the pounding of the rain and the roar of distant thunder. There had been something else—there! From the front of the house, a sound mid-

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way between a scratching and a tapping. It was not loud, compared to the other storm sounds, but it should not have been there at all. He got up, wondering if something had been torn loose by the wind and was now battering his door. Or if somehow one of the sheep had somehow escaped the adjoining barn and was now scraping at the door for shelter.

The wind nearly tore the door from his hand as he opened it. A man stood before him, face dark with at least a week's growth of beard. His clothes were torn. Three other figures huddled behind him under the overhang.

"I'm sorry to bother you," O'Donnel Buergher-Murchison said hoarsely, "but my friends and I have had a bit of trouble. May I use your comm set to call my mother, please?"

O'Donnel Murchison. Judith Speigelman-Fromm. Anderson Perry-Barlow. Maria Castillo-Schmidt. They had done something no one else had done since the first landing. They had crashed in the jungle and walked out on their own.

V.

The screen above the bed gave most of the basic facts: blood pressure, pulse rate, body temperature, white blood cell count, respiration, oxygenation levels, metabolic rates, fluid input and output. Most of the facts and none of the answers.

"When can I go home?" O'Donnel asked.

Rey followed the IV lines down to his patient. "When you are well enough."

"I just did a hundred-kilometer hike in the jungle. Doesn't that mean I'm in pretty good shape?"

"Considering what you went through, you are in astoundingly good shape," Rey answered. "You should be ready tomorrow, or the next day for sure. After all, you were in the jungle more than two weeks. Even the Bainbridge expedition was beyond the cordons little more than one week, and they started fully outfitted, and were resupplied on their way. The fact is, a lot of people can't understand why you and your friends are alive at all."

"I'm almost sorry to disappoint them," O'Donnel murmured.

"No need to be," Rey replied, "but there are some questions which need answering. You were on minimal rations, on a trek which must have required a great deal of endurance. You seem to have lost some body fat, and you may have the beginnings of a few deficiency diseases. Yet Belkom, who had most of the emergency rations, died of starvation."

O'Donnel's face clouded. "None of us wanted to leave him," he said, "but there was no way he could've walked. The emergency packs were supposed to contain enough rations for all of us for five days. We took three days' rations for ourselves and left the rest for Belk."

Rey thought back to the pile of cartons in the VTOL. "Why did you split it up that way?"

"We figured we weren't that far from Far Edge, so three days should do it." He shrugged. "Big mistake, huh? Even though we tried to keep to the ridge, the tree cover was so thick

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we'd lose sight of the sun. Every two or three hours, one of us had to climb a tree to see if we were still walking in the right direction. Lots of times, we weren't.

"And the rations weren't nearly enough! Each of them was supposed to last you a day, but we'd eat one during a stop and be hungry two hours later."

Which suggested one line of investigation: if the contractor who packaged the emergency rations had shorted the contents, it might explain why Belkom had died. Although, as Marty had remarked, it was odd that anyone should die of hunger in a week even if he had had no food at all. In Belkom's case, the additional factors of trauma and blood loss must have greatly weakened him.

"Why did you leave the VTOL?" Rey asked.

O'Donnel shook his head, aware of the implied criticism. "We didn't think you'd ever find us. All the radios had been destroyed by the crash. We waited two days before starting the trek. We could hear VTOLs both days, but nobody ever spotted us. I figured we were just too deep below the canopy, and that we would have to save ourselves."

That was close enough to the truth. Regan Lee's friends had mounted an experimental infrared sensor array and metal detectors on the *Sunbird*'s wings. That, and the fact that the *Sunbird* was able to stay on station longer than the VTOLs and so make a more thorough search, were the only reasons the downed craft had ever been located.

"Fair enough," Rey said. "I guess the main question now is how the four of you managed to survive as well as you did. Your exploits have made you the heroes of the news net."

O'Donnel looked skeptical.

"No, really," Rey insisted. "What's important, though, is to learn whatever we can from your experience. If your rations were inadequate, then we want to establish that and have someone swing for it. On the other hand, if you discovered some way of improving the odds of surviving in the jungle, it is important that everyone else on the planet learn of it."

O'Donnel nodded. "There isn't much to tell. We just discovered that we could live off the land. At least, a little bit."

It was Rey's turn to look skeptical.

"It started with water," O'Donnel continued stubbornly. "The ration packs made us thirsty. There weren't any streams on the ridge, but I was afraid we would become completely lost if we went lower. Then we looked around, and discovered that in between the trees there was ground cover which looked like leaves as big as your arm. Lot of these leaves contained little puddles.

"So we tried to drink them while spilling as little as possible. One way was to put your mouth on an end and slurp. That's how we found that the leaves tasted good. So we started eating them."

"The leaves as bulk would have been somewhat filling," Rey said judiciously, "and your body may well have been able to extract water from

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the leaf tissues as well as what was lying on the surfaces. Did you eat anything else?"

O'Donnel nodded. "There were these things Judy called pine cones 'cause they resembled something she'd seen in the Terrace's big arboretum. They were scattered all over the ground. Had kind of a nutty smell. I don't know why she started eating them, but she did and told us they tasted good. We'd stuff our pockets, then eat as we walked."

"You are lucky you didn't poison yourselves," Rey said. "Were there any adverse reactions?"

"We all had cramps," O'Donnel admitted, "at least, at first. I may have had a fever part of the time."

"You still do," Rey confirmed. "It's coming down slowly. Any other problems?"

"No." O'Donnel thought a moment. "Y'know, it's strange. We were tired and hungry and scared that we wouldn't make it all the time we were in the jungle, but in some ways it was really neat. Maybe it was just that there was more oxygen at a higher pressure than I'm used to. But all my life I've been told how awful and dangerous the jungle was, but when we were there it was, well, pretty.

"I'd like to go back sometime."

"Maybe," Rey said, "but only after you are completely recovered." *Lots of luck getting permission from the Committee on Colonial Security.* "In the meantime, I'd like to run more tests. This will mean getting poked and prodded, and submitting to the additional indignities of giving blood and stool samples."

"You make it sound irresistible," O'Donnel muttered.

"On the other hand, we may be able to learn something from you and your friends that will save lives in the future."

O'Donnel rolled his eyes to the ceiling with a sigh. "Let's get on with it, then."

The answer came early that evening. He had sealed his samples into their small plastic dishes and placed the dishes in the trays of the automated microscopes, there to be cared for by the medical AI programs until he could make time to conduct an examination.

An alarm went off. It was a soft-spoken, almost deferential alarm. Instead of screaming a strident warning, it seemed to say "Take a look over here; this may interest you." What it most likely meant was equipment failure or a mistake in programming parameters.

"Computer: alarm visuals, please." Then he kicked himself mentally as he remembered that voice activation was one of the many frills the clinic did without. Muttering, he punched in the proper command.

The screen glowed to life. Strange shapes moved like shadows, elongating, their trifurcated ends grasping for nourishment, then curling up into balls for no apparent reason.

"What the hell?" His tone was almost reverent. He tapped a series of keys.

ACCESING MICROORGANISM DATABASE.

Twenty seconds elapsed. NO MATCH FOUND.

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"That's what I thought." Another series of commands established a satellite link to the Terraces.

"Security authorization." The voice was tired and more than slightly irritated.

Rey frowned. "Since when does a colony clinic need a security clearance to access a medical database? I thought that was what our taxes were for."

"Who—? Is that you, Rey? How are things on the frontier?"

"Mongosuthu?" Rey guessed. "You used to have a real job as a researcher. What's going on back there?"

"Things are even crazier than usual," Mongosuthu grumbled. "Naturalers got into a lot of the systems two weeks ago, looking for evidence of some grand conspiracy to suppress 'the Truth,' whatever that might be. Colonial Security had a fit, thinking they might crash the databases. My part-time job as gatekeeper is one of the results.

"Here's what we do. When you hear someone request your authorization, you say 'Medical priority.' Say that now a few times, so we can put your voiceprint into memory."

Rey did so.

"Good. Try to sound as natural as you can when you call in. The program is supposed to evaluate stress in case you're being coerced. So far it's shut out three docs calling in for emergency support.

"Now that that's all taken care of, what can I do for you?"

"I have some beasties for you to look at," Rey said. "They are not in the standard references." He keyed in the visual from the microscope.

"Hmm. Bizarre looking," Mongosuthu said. "Where do they come from?"

"The intestines of one of my patients."

"Any symptoms?"

"None I can be sure of. He was in the jungle for a couple of weeks, and is about as tired and exhausted as you might suppose."

"Ah! So this is one of the missing rock climbers. Wait—" Five seconds elapsed. "The AI diagnostic suggest some sort of parasite. No match in the records, though. Those trifurcations are a pretty dammed distinctive morphology. If it were anything terrestrial, it should be in the database. But if it's native, it shouldn't be able to exist in a human gut. Any idea how he became infected?"

"He says they ate some of the native plants," Rey said.

"Well, that explains it. Your boy ingested some of the local fauna, which not only came with assorted bugs, but also created an intestinal microhabitation which was not immediately fatal. He's lucky it didn't kill him."

"I've already told him that," Rey agreed.

Rey readied himself for bed, mind awhirl with thoughts which went nowhere but would not settle down. He pulled the sheets up, enjoying the scents which had permeated them as they hung outside to dry. He took a deep breath and let it out slowly, reveling in the simple act of breathing.

And stopped. He had left a breathing mask high in a tree more than

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three days earlier. In the excitement, he had forgotten to unwrap a replacement. He had even forgotten his antihistamines. And never in his life had he breathed so easily.

He sat up, suddenly wide awake.

"Mind telling me just what the hell you're doing?" Marty asked sleepily. It had been her night to sleep in the clinic, in order to take emergency calls. Rey had tried to move around quietly, but obviously he had not been quiet enough.

"Research," he said. "I got an unexpected lead on why nobody here has allergies."

"Really?" Martina asked skeptically. "Like what?"

"Like I suddenly remembered an old theory that allergies were the result of an underworked immune system. Take a look at that first screen."

"I see it," Marty said. "What is it?"

"You are looking at a stool sample from O'Donnel. The things you see wriggling around have been tentatively identified as native parasites, though they aren't on any database. Now, it's an odd thing, but the archives note that back on old Earth, human population that was infected with any of the local parasites rarely if ever suffered from allergies. That was a disease of what you might call the overly-hygienic. The theory was that a substantial part of the human immune system had evolved to deal with parasites, and that when they were absent, the system went into overdrive, reacting against basically harmless dust and pollen particles.

"Conversely, if parasites were present, allergies would disappear."

Marty sat down heavily on a stool and blearily regarded the monitors. "Excuse me for being dense this late at night. Or this early in the morning. But doesn't it occur to you that whatever your explanation does for O'Donnel and his friends, it has no relevance to the rest of us?"

"Take a look at the second screen," Rey suggested. "How would you say it differs from the first?"

She squinted uncertainly from monitor to monitor. "Not at all that I can see."

"That second screen is from a sample I provided," Rey said. "I'm willing to bet that everyone on Far Edge is infected."

VI.

Six days later, Rey woke to learn that the Committee on Colonial Security had placed Far Edge under interdict. Neither people nor goods would be allowed into or out of the colony.

"Big deal," he muttered at the breakfast table. "There hasn't been any contact to speak of with the other colonies since I came here."

Ryn-Rosenberger frowned. "The winter winds should cease by the end of the month. We need the zeps for heavy machinery, for new satellite dishes and fiber-optic cable. For that matter, do you plan on culturing your own drugs when you run out of your current supply?"

Rey grimaced, acknowledging the sense of that statement. He shoveled food into his mouth, resolving to wake up more fully before taking the next opportunity to make a fool of himself.

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"Rey, excuse me." Juanita Buergher-Murchison stood by his side, holding a small handset that was part of the building's communications system. "Councilor Mercer-Konare needs to see you at the Town Hall. He has been trying to get through to the Terraces. They say . . . they say you are the reason for the Interdiction."

The Town Hall was a single-story rectangle less than a half a kilometer from the clinic. Its hollowed center was a courtyard which, in good weather, was used for public ceremonies. The outside walls were braced and insulated by sod. Three of the wings were offices, usually vacant. The fourth was a theater, sometimes used for town meetings and amateur dramatic productions.

Rey had to push his way inside past the knots of people who were rapidly filling the theater. On all sides, voices were raised in argument, some angry, some fearful. As he shouldered his way through one of these groups, someone recognized him.

"Hey, Doc, what's the story?" A strong hand reached out and grabbed him. "You haven't been snitching on your friends, have you?"

Rey turned, trying to shake the hand off. "Of course not. Now let me go and—"

Another arm reached across, grabbed the hand strongly enough to elicit a grunt of pain, and shoved it away.

"You take it easy, Bart." Mercer-Korare usually had the self-assurance which went with being the largest Freeholder in the colony. Now his face was flushed and shiny. He might have been afraid. Yet this made him seem more formidable, like a large wounded animal. Rey's assailant seemed to recognize this, and drew back, muttering.

"Glad you could get over here, Rey." Mercer-Korare spoke close to his ear in order to be heard over the din of voices. "I don't know what those morons at the Terraces have—"

"Dr. Reynolds Morrill-Landers." The voice came over the loudspeakers with a whipcrack of authority. The commotion dwindled away to silence. Looking around for the speaker, Rey noticed for the first time that the curtains at the front of the theater had been drawn aside to reveal a huge video screen. An austere face, wispy white hair framing an oddly delicate skull, seemed to regard him with the disdain he might have reserved for a substandard laboratory specimen.

"I am not a doctor," Rey said, in the sudden silence. "I am a medical master."

"You're the closest thing on Far Edge," Governor Calley-Li replied, in a voice which would brook no argument. "Except for your research, we might not have discovered the danger until it was too late."

"Is identification of this great danger too much to ask?" Mercer-Konare queried.

"Years ago, when the establishment of Far Edge was being debated, I spoke against it," Calley-Li said. "I felt that, at such a low elevation, even the protection of the best cordons would

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be problematic. Two years ago, the child of one of our most prominent Freeholders was stolen by the so-called White People, and an alien changeling left in his place. Soon thereafter I became governor and began instituting measures for the public safety. The strengthening of our police forces, the passage of the data access law, the formation of the Committee on Colonial Security were all part of my—"

"We know all that!" someone shouted.

"Yeah," another voice agreed. "Save this for the election. Just explain why you're screwing with our shipment schedules."

"Quiet!" Mercer-Konare commanded. To Rey it seemed that he was not really displeased with the outbursts.

"Thank you, Councilor," Calley-Li said, as the shouting subsided. "A few days ago, Master Morrill-Landers reported through medical channels the existence of a parasitic infestation which has apparently infected every member of your colony. We cannot take the risk that it will spread to the other colonies. For this reason, all contact with Far Edge is prohibited until it can be proven that the infection has been eradicated."

"My reports were protected by physician-client privilege," Rey protested. "Any violation of that is actionable."

The governor blinked, surprised. "You mustn't worry about that. The data access laws specifically provide that such files may be opened in the case of state emergency. By definition, no privilege exists under such conditions, and therefore it cannot be violated."

"Governor, with all due respect," Mercer-Konare interposed, "do we look like plague victims? I assure you that I am in the best of health. And so are my fellow citizens."

"There have been many diseases with long incubation periods, such as AIDS and cancer," Calley-Li answered. "They were no less fatal for that."

"Just how are you going to enforce your decree?" a woman behind Rey asked. "We have our own VTOLs. Once the winds shift, we'll be able to trade with the nearer colonies on our own. Are you going to have them shoot us down?"

"If it is necessary to contain this plague," Calley-Li said, his voice quivering, "I will have Far Edge replaned."

The room fell silent. Videos from childhood replayed themselves in Rey's imagination: frozen mountain peaks vaporized by an instant, eye-searing glare. Thermonuclear fury creating a plateau which, when it cooled, would be seeded with Terrestrial microbes to produce soil.

"You wouldn't," Mercer-Konare whispered.

"I will do whatever is necessary to preserve the human race on this planet," Calley-Li said. "This may well be the first attack of the White People. It cannot be allowed to succeed. Ask Morrill-Landers if I am exaggerating the danger."

Heads turned toward him. *A simple "You sure are," is not going to suffice*, Rey thought.

"I think," he began, and paused to

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swallow so that his voice would sound like something more than a squeak. "I think it is a tremendously selfless statesman who is willing to sacrifice his daughter for the good of the community."

Calley-Li's eyes blazed. "What does that mean?"

"I'm talking about the Old Earth Days Ball several months ago," Rey said. "Your daughter, Andrea, was paired a good deal of the time with O'Donnel Buergher-Murchison. The first parasites I discovered came from O'Donnel."

"This is entirely irrelevant."

"The parasite exists throughout the entire digestive systems," Rey continued doggedly. "The spores are found in the intestines, the stomach, the throat, even the mouth. Little more than casual contact is required for transmission."

"My daughter has not—"

"—Done anything wrong or even unusual," Rey said. He spoke more rapidly, afraid Calley-Li would cut him off before he could finish. "A simple kiss would be enough. All she would notice would be an increase in appetite which wouldn't show up on her waistline. And maybe that her allergies didn't bother her any more. Ask yourself: has she been careless about wearing her breathing mask? Has there been a recent weight loss? Has she stopped taking allergy pills?"

"I don't have to listen—" The image cut off abruptly. Rey stood staring at the blank screen. The swell of voices rose around him. The room seemed suddenly uncomfortably hot. He shouldered his way through the arguing groups. Stepping outside, he was nearly blinded by the daylight. The intensity of the early morning sun was a shock. For an instant, he imagined the detonation of a thermonuclear bomb. He wondered if there would be time for anything other than instant annihilation, whether he would sense the flash and feel the pain as his skin turned to ionized gas.

"You have an interesting way of dealing with authority," Mercer-Konare said.

Rey looked around, surprised to see that the councilor had followed him outside. He shrugged. "I had to do something to get his attention. You know, they make a big deal about being the repositories of human culture, Homer, Socrates, Augustine, Lao Tzu. . . . Yet sometimes, it seems that all they really study are Dr. Who episodes where some alien virus turns everyone into stiff-legged monsters. This planet, which has been our home for generations, fills them with fear.

"It's almost funny. Calley-Li thinks the Alienists are depraved and defeatists, yet all they do is put into art everything he believes."

"How did you learn about his daughter?" the councilor asked.

"I don't know anything about his daughter, except that she was Don's date," Rey said. His lips twitched. "I don't know that she was infected, or even that you can be infected by person to person contact. I haven't gotten that far yet. But then, I don't know that you can't. And Calley-Li certainly doesn't know that you can't. I'm hoping it'll give him pause."

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A man was approaching them. With a sinking feeling, Rey recognized Bhagwati. *He'll never believe I kept his secret.*

But it was Mercer-Konare to whom he wished to speak.

"Councilor," he said, his voice shaking with agitation, "I fear that I am the cause of this plague."

Mercer-Konare stared at him. "How so?"

"My sheep," he said, sounding miserable. "As I listened to the governor, I realized that my sheep, grazing beyond the cordon, must have ingested the parasite and then spread it to the rest of the colony."

Mercer-Konare turned to Rey. "Is that possible?"

"I suppose," Rey said doubtfully. The parasite's presence might explain why bloodbirds persisted in attacking sheep. They would taste or smell something familiar which had, in the past, been associated with nourishment. It might also explain why breaking a bag of blood caused bloodbirds to release their hold, since the artificially cultured blood supplies would lack the parasitic traces. Yet. . . .

"The problem is, I don't think we can establish that everyone on Far Edge has eaten your sheep," Rey said. "Most of what you raise is for export. Most of the local consumption comes from the herds of the other Freeholders. As far as I know, their sheep graze on the legal side of the cordon."

He said the last sentence slowly, giving both of them ample time to contradict him. Bhagwati nodded sadly. Mercer-Konare, however, looked suddenly excited.

"Maybe there are several modes of infection," he said. "Maybe sheep grazing beyond the cordon is only one. Nonetheless, I bet those sheep are infected. And if they are, then so is everyone who ate them. You're right in supposing that most of Freeholder Bhagwati's sheep are exported. In fact, most of them go to the Terraces."

His gaze turned inward. "I suppose I must communicate this to the Terraces, as well as to any other colonies which may have received infected sheep. It would not do to have the governor's efforts to contain this plague thwarted by a failure to appreciate just how widespread it is."

The councilor walked back to his office, humming happily to himself.

VII.

Days of anticlimax stretched into a week. An underlying tension ate into the pit of Rey's stomach. He would wake up wondering: *Is this the day some maniac is going to blow us to hell?* Then he would push it out of his consciousness and get on with the day's work. But it stayed just beneath the surface of his thoughts, gnawing at him.

Mercer-Konare asked everyone to prepare a list of those vital supplies which were in short supply, presumably in order to set up a rationing system. Rey and Martina printed out their inventory of medical supplies, then went over it to see what could be made locally. Bandages and splints could be fabricated from cloth and plastic scraps. Alcohol for disinfec-

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tant use could be distilled. Very simple tissue grafting could be done in the clinic.

On the other hand, antibiotics and immune system enhancers were both in short supply. There were no resources to support serious surgery or any kind of gene therapy. That sort of work had always been done in the Terraces.

They turned in their lists, revised a few of the clinic procedures to stretch out supplies as far as was consistent with patient safety, and continued on their rounds. Martina spent as much free time as she had with O'Donnel and his three friends, trying to devise new tests to determine why they had not starved to death.

A few guesses were confirmed. All of Bhagwati's sheep were infected with the parasite. As were all other flocks, and all humans except newborn babies. Analysis of the oldest records indicated that the infection had originally spread west to east. Since that was for most of the year the direction of the prevailing winds, Rey began to suspect that something like airborne spores might be the mechanism of contagion. If so, then no cordon could provide protection. No colony this close to the world jungle would ever be safe.

On the seventh day, a comm call woke Rey while it was still dark.

"Santa Claus is coming to pay a surprise visit," Mercer-Konare informed him. "You should be on hand to greet her at the airfield."

A small group of men and women had already assembled by the time Rey reached the communications shack. A mug of hot coffee was pressed into his hand to ward off the pre-dawn chill. He sipped it gingerly, trying to keep it from scalding lips and mouth as his eyes quartered the sky.

There was an exclamation behind him, and an arm pointed to the east. Rey squinted in the direction indicated. At first, he could make out nothing against the featureless dark blue expanse. Then a flash caught his attention. It was the *Sunbird*, bathed in the advancing light of Tau Ceti. It was dropping quickly to the landing pad. To Rey's eyes, its movements were sluggish; it seemed to wallow in the air.

"... Hope she didn't overload ...." a woman behind him muttered.

The *Sunbird* came straight in, hard and fast. Its wheels smacked the pavement and bounced. Wings quivered like an angry butterfly. The fans came to life with a sudden roar, twisting the craft around so that it stopped with its tail brushing the fence at the edge of the cliff.

Regan Lee jumped unsteadily onto the pavement and waved to the crowd which had run up to greet her. Seeing Mercer-Konare, she reached back into the cabin for a large envelope and handed it to him.

"Here's the manifest. And a few letters from people who don't want to trust the satellite links for privacy."

The councilor thanked her. He examined the manifest, grunted, and began calling out names of those he wanted to help with the unloading. Regan spotted Rey and walked over to him.

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"Hi, Doc. You've really stirred people up since I dropped you here."

"Not intentionally," he mumbled, feeling oddly tongue-tied.

For some reason, her face split in a wide grin. "C'mon. I'll show you your presents."

There were three large boxes. Each had its contents listed on a sheet taped to one side. The first contained immune system boosters and pheromone regulators. A quick check disclosed that, at the normal rate of usage, these would last perhaps three months. Most of the second box was filled with a laser scalpel set, complete with spares, and attachments for local nerve deadening.

The third box was the most interesting. Instead of antibiotics, they had received an antibiotic culturing kit. More than thirty basic antibiotics could be grown in the glass trays from the dehydrated sample bags. It was not nearly as convenient as receiving pills or nasal sprays. With proper care, however, it could last decades.

Rey considered the implications. "I guess we're getting ready for the long haul."

"Maybe," Regan agreed. "It sure never hurts to be prepared."

"Are you prepared?" Rey asked. "Won't you get into trouble for breaking the embargo?"

Her smile was as dazzling as the morning sun. "The orders were very specific. All classes of VTOLs and zeps were prohibited from flying within fifty kilometers of Far Edge. No mention was made of powered gliders or any other type of experimental vehicle."

"Calley-Li will not let you get away with that for long," Rey warned.

"I may not have to," Regan said, tossing her head.

Rey was about to ask her what she meant by that when Mercer-Konare came over and invited them to breakfast at the Town Hall. Realizing abruptly that he was famished, Rey secured the boxes to the struts of his dragonfly, then joined the crowd ascending the twisting walkway to the hall.

Inside, there was a mood of restrained celebration. Happiness at having the embargo broken was tempered by the understanding of just how small the break was. From the scraps of conversation he picked up as he made his way to Regan's table, Rey learned that everyone else's shipments had been as limited as the clinic's. New chips and circuit boards had been provided when needed, but replacement parts for broken mining equipment or harvesters had been too large and massive for the *Sunbird*. If they could not jury-rig replacements, they would have to do without.

Rey felt irrationally pleased that the seat across from Regan was unoccupied. As the last of the unloading crew took seats, Mercer-Konare stood and tapped his tea cup. Silence fell, except for the servers bringing in the breakfast trays on roll carts.

"Before we start eating, I think we want to show our appreciation to the brave young woman who was willing to ignore the dictatorial decrees of the colonial governor and who, at great risk to her own safety, has brought us back into contact with the

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rest of humanity on this planet. She has brought with her a number of communications that I don't have time to summarize but which prove that we have many supporters throughout all the colonies. For that alone, she deserves our gratitude."

The applause was loud and prolonged. Regan's blush was surprisingly visible despite her skin coloring.

She stood and made a slight bow to her audience. "While I have your attention, I have one more communication which I did not provide the councilor, because it was not addressed to him. I would like you all to hear it."

She opened an envelope and extracted a large, formal looking document. "By the authority invested in me by the School of Apollo, I hereby grant to Reynolds Morrill-Landers the degree of Doctor of Medicine."

She leaned over, handing the parchment to Rey and giving him a quick kiss. More applause, followed by some laughter at his dumbfounded expression.

"Ah, but I haven't presented a thesis yet."

"Your adviser, Dr. Mongosuthu, wants you to know that 'An Analysis of Some Effects of Indigenous Parasites on Human Allergic Response,' is scheduled for the summer issue of the *Apollo Journal of Medicine*. He urges you to clean it up for publication as soon as possible."

Breakfast trays were placed before them and all talk was replaced by a reverent hush, broken only by the occasional clatter of silverware.

"That is our other long term problem," Mercer-Konare said at length, regretfully regarding his empty plate as he put down his knife and fork. "We've made it through the winter largely on stored goods. Those vegetable gardens nearly everyone grows were meant to supplement our diets, not sustain them. We will need to see if we can cultivate enough acreage to sustain the entire colony. If we can't—"

"If we can't, we may have to live off the land, just like the Naturalers have always wanted," Martina Mazio-Carr said.

She pulled a chair around to join them and leaned on its back. "How can we do that?" Rey asked.

"The same way O'Donnel and his friends were able to," she answered. "For that matter, it's the same way Bhagwati's sheep have been able to thrive on fields which are mostly native vegetation."

The table fell silent. Satisfied that she had their attention, she continued. "Rey has already given you most of the pieces of the puzzle. Through the process of convergent evolution, a native variety of protozoan has modified itself sufficiently to live in our digestive systems. It hasn't had the severe effects terrestrial parasites used to have, probably because it has not been able to completely adapt to its new host. A fair amount of our diet must be useless, if not actually detrimental, to it.

"But if our diet is not completely nourishing, much of the local fauna is. The effect of that is—"

"That these aren't parasites at all," Rey interrupted excitedly. "I let my-

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self be misled by the allergy response. What we have is . . . symbiosis?"

"Looks like," Martina agreed. "Or at least something reasonably close. It's hard to say because we are trying to identify something while it's still trying to change to adapt to us. If it were a successful parasite, we might find ourselves devoured from inside. If it were a fully evolved symbiote, on the other hand, our immune systems wouldn't attack it and we would still have allergy problems.

"Most of the native plants have starches and sugars too complex for our digestive systems. The symbiotes break these down into human-usable form."

"Then that's how O'Donnel's party was able to survive," Rey surmised. "Despite everything we've always been taught, they were able to metabolize a fair proportion of what they ate."

"It is also the reason Belkom Michaels-Nye died," Martina said somberly. "Normally, the symbiotes are not dangerous to us. Aside from reducing allergies, their effect is to increase our appetite. Put another way, there is a caloric price for allergy reduction. Belkom was stranded with supplies apportioned for uninfected humans. When they were gone, the symbiotes became parasitical, deriving nourishment from what was closest at hand. Which was Belkom."

Rey dropped his eyes, feeling embarrassed. He put his certificate on the table between them. "I think they awarded this to the wrong person."

"Probably so," Martina agreed, "but I'll get my recognition soon enough. Provided, of course, that the governor and his friends don't vaporize us in a fit of panic."

VIII.

As it turned out, they had nothing to worry about. That afternoon, a news flash reported that Governor Calley-Li had been found dead in his study. The laser pistol held in his hand had been the cause of death.

Two hours later, a shaken Acting Governor Normana Girouard-Sime announced a partial lifting of the embargo against Far Edge. All goods would be allowed into the colony. Manufactured goods could be exported. If the School of Apollo determined that the infection was basically harmless (as it was expected to do shortly) all further restrictions would be lifted.

Darkness swept up from the jungle far below and shadowed the sky in ever deepening shades of blue. Stars appeared, pinpricks of cold fire.

Rey felt, rather than saw, Regan beside him. "What are you looking for?"

He pointed. "That bright star up there is Arcturus. If you look just to the right of it, you'll see a dim little star."

"Sol," Regan said. "Manhome."

Rey nodded. "My advisor pointed it out to me my first year at Apollo. He told me how, for nearly a century, humanity thought it knew everything about the nuclear reactions that made it shine. Then, in the latter part of the twentieth century, experimenters realized that there were too few neutrinos being produced for their model

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to be true. Just by itself, that should have been enough to demonstrate that they knew nothing. Yet for years they questioned their data, concocted extravagant theories, and almost until the end had no idea how quickly doom was racing down upon them.

" 'Whenever you look at Sol, think of how little you know,' he said, 'And consider how much of what you do know may not be so.' "

"Then you should be happy," Regan said in a slightly reproving tone. "You've done a good job decreasing the circle of ignorance."

Rey shook his head. "It took me forever to see the obvious. When I started putting things together, I still had no idea what sort of reaction my findings would provoke. Then when I tried to get our sanctions lifted, I pushed a man into suicide."

"There is no point in feeling sorry about Calley-Li," Regan said sharply. "The man was a victim of his own fears. He panicked because he thought this plague, which never did anything except make people healthier, was going to subvert our humanity."

"He was right," Rey said.

Even in the darkness, he felt the weight of her regard. "If you believe that," she said at length, "then why haven't you done everything in your power to eradicate it?"

"Because even before the plague, Calley-Li's efforts were doomed to failure." He took a deep breath, trying to sort through a welter of facts and emotions. "Did you ever notice how much effort is devoted in other colonies to raising the various tea crops? When you consider that we derive no nourishment from them, it's quite extraordinary. But we do it because for a lot of people it is important that we have teas and tea times. More important than actually having food to eat."

"So what?" Regan asked. "We can raise both."

Rey shook his head, frustrated that he was doing such a poor job of expressing what he could see so clearly. "It's the reason that's important. We want to have tea ceremonials like our Japanese ancestors did; we want to have tea times like the British. We want to pretend that we are nothing more than an outpost of human empire and that everything will stay the same forever if we dress for dinner and keep the Old Earth Days traditions alive.

"The problem is that it can't work. First of all, any isolated population soon begins to show genetic drift. The College of Apollo has statistics to show that is already happening. Because they are disconcerting, they aren't widely known.

"More than that, though, we are evolving to fit the planet. Read the old diaries if you can't remember the stories your grandmothers must have told you. It was very difficult for women to conceive and bring children to term during the first two generations. All that remain of that now are problems with irregular menstrual cycles. We have adapted successfully."

"I don't consider that a problem," Regan said.

"I don't either," Rey admitted, "but Calley-Li saw further. He recognized that it is only a matter of time before we drift so far that we won't be able to breed with humans who have settled around other stars. We will have

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become a separate race.

"What he learned from me was worse, though. Not only were we adapting, but the biosphere was adapting to us. Something strange and alien was making its home within us. He couldn't have known what Martina would discover about being able to digest some native plants, but I think he imagined it. And in his imagination, humans became as ghostly and strange as the White People. We would lose our culture, our beliefs, all the memories and mental disciplines which made us human."

"That does not have to happen," Regan protested.

"No," Rey agreed, "it doesn't have to happen. But it could, very easily. I rubbed Calley-Li's nose in it, and it was too much for him. Especially when he discovered that his own daughter was tainted by the alienness he so feared."

He found that his eyes were wet. He wept for Calley-Li, for the dream of safely cordoned island societies, for the Old Earth they had tried so diligently to resurrect. Regan put her arm around him, comforting him.

The path had taken them to the edge of the cliff. Scents floated up from the jungle far below. It was going to be their world, Rey realized. They would change it, and it would change them, and it would be as exciting and as dangerous as it had been on Earth.

Regan was startled by his sudden laugh.

"All this time, the Naturalers said we would have to learn to live off the world to come to terms with it," he explained. "Instead, we have become part of the world because it has learned to live off us." ■

EDITOR'S NOTE: This story is a sequel to "The Changeling Hunt," which appeared in our July 1987 issue.

(Biolog continued from page 129)
different viewpoints and far-out ideas often found in an *Analog* story. The thought processes of ET aliens do not seem outré or silly. *Analog* writer Dr. William Wu is being slowly joined by other Chinese writers in the SF field, and even a female SF artist. Western technology is being influenced bit by bit by Oriental viewpoints, *Analog* as usual somewhat ahead with its depiction of possible futures.

On a day-to-day basis, Tina, with the help of Senior Associate Editor Scott L. Towner and Editorial Assistant Sharah Thomas, keeps *Analog* rushing towards monthly deadlines, overseeing each step and coordinating the specialized department staffs of art, production, advertising, and circulation. More than a half-century back, the editor of this magazine transcended his time, place, and upbringing to offer readers the marvelous thoughts of people exotically named Del Rey and Asimov or just as surprisingly called Catherine. Now the second-in-command position has gone from once unlisted anonymity to Senior Managing Editor, held by a young woman with parents from a Chinese village so obscure it can't be found on a map. Fifty years ago Tina Lee's story would have been credible only to readers of *Analog*. ■

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THE REFERENCE LIBRARY Tom Easton

Invader, C. J. Cherryh, DAW, $19.95, 426 pp. (ISBN: 0-88677-638-4).
Solis, A. A. Attanasio, Harper Prism, $4.50, 214 pp. (ISBN: 0-06-109092-1).
Celestis, Paul Park, TOR, $21.95, 288 pp. (ISBN: 0-312-85899-X).
Orion Among the Stars, Ben Bova, TOR, $22.95, 320 pp. (ISBN: 0-312-85637-7).
Dead Girls, Richard Calder, St. Martin's Press, $19.95, 206 pp. (ISBN: 0-312-13045-7).
Fire in the Sky, Jo Clayton, DAW, $4.99, 352 pp. (ISBN: 0-88677-650-3).
Living with Aliens, John DeChancie, Ace, $4.99. 183 pp. (ISBN: 0-441-00204-8).

With so much trivial, derivative schlock out there, it is an event, folks, when one of SF's stars delivers herself of something fresh and strange and wonderful. It is even more of an event when the sequel is quite as good as the series' opening volume, and perhaps even better. If the third volume lives up to the expectations the first two built, said star will see her name in lights forever and surely die as rich as Croesus. (Or so 'twould be if this world knew what justice was.)

Am I raving? Well, if you dashed out and bought C. J. Cherryh's *Foreigner* on the strength of what I said in the July 1994 column, you found (I hope!) that something fresh and strange and wonderful. She posited a human starship laden with the builders and residents of a planned Station, marooned in unrecognizable space, far, far from human civilization, struggling to reach a world that turned out to have natives, the atevi, whose psychology wasn't really much at all like that of humans. After a time of conflict, the two species constructed a *modus vivendi* that set up a single human, the paidhi, as translator, mediator, and conduit for human technology. The paidhi had to be steeped in atevi psychology to the point where he sometimes felt estranged from humanity, but that seemed a reasonable price.

Foreigner was the tale of paidhi Bren Cameron, who sometimes thought he understood the atevi. He even liked them. But he kept being reminded that "like" was not in the atevi psychological vocabulary. There was neither friendship nor love, only alliance, and when someone tried to assassinate him, he was hurled into a thoroughly confusing deep-immersion study of the atevi culture that wound up demonstrating that there really was a potential for friend-

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ship—for "liking," even—and for partnership between the species. And then there appeared in the sky a new star—the starship that had brought humans to the atevi world had returned after 200 years of absence.

The sequel, **Invader**, begins with an injured Bren Cameron, groggy from pain-killers, yanked out of the hospital to cope. The atevi are panicking over what they fear may be a threat in the sky. The human settlement—run, we quickly see, as much on alliance as any atevi group—has tried to replace Bren with his successor: incompetent, disruptive, serving a conservative agenda that aims to make humans top dog. And the ship-folk want to encourage the planet-dwellers to get into space and fetch them supplies. Not to mention that some female atevis—including one of Bren's bodyguards—seem to wish he would do something scandalous with them.

Poor fellow. He really doesn't have much choice. He is, after all, the sole designated mediator between humans and atevi. He *has* to speak to the ship, to explain the situation, to make proposals and deals, even though the human settlement promptly brands him a traitor to his kind. He sees his "kind" more broadly, and yes, just as hinted in *Foreigner*, there do seem some grounds for liking and alliance and partnership between the species. There are differences, but there are similarities as well, powerful ones, ones that indeed make the atevi seem a bit nobler than Homo sap.

The tale ends with the arrival on the ground of two young people from the ship's crew. They are to learn the local languages and become translators and mediators—paidhis, if you will—between the ship and the planet-dwellers. One will go to the human settlement. One will stay with the atevi.

The third volume will have a three-sided relationship to negotiate. It will have immense potential for conflict, and I am sure that Cherryh will manage it as vigorously and convincingly as she has done so far. I also expect that we will see more emphasis on the similarities of human and atevi and the growth of a true, strong partnership.

Don't miss this fast-paced, vigorous, thoughtful series. Cherryh is in rare form.

A. A. Attanasio's **Solis** appeared last year in hardcover. I finally got to it in paperback, and now I can say: It offers a strange and wonderful, or strange and fearful, or maybe just plain strange vision of the future. The basic gimmick—a brain, frozen in our day, is thawed out and awakened in the distant future, only to find that the future has very little regard for brains from the past—is familiar. The strangeness lies in the nature of Attanasio's future.

The brain in question belongs to Mr. Charlie (Charles Outis). It was found by lewdists who delighted in his memories of sex (it's been obsolete for ages), captured by the Friends of the Non-Abelian Gauge Group (genetic math freaks), and finally liberated by the Commonality, which interrogated him about his previous captors and promptly peddled him to a space min-

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ing outfit that enslaved him as a mining machine supervisor (artificial intelligence is too expensive).

Since Mr. Charlie is not very happy in his new role, he adapts the machinery to send off a broad-band message. It is picked up by Munk, a robot built by the Maat, genetically engineered superintelligent humans who exist largely off stage, and equipped by them with a fixation on understanding humanity. Munk immediately mounts a rescue mission, fights off a vicious "salvage" operation, and gets the brain to Mars, where possession, identity, and destiny become the center of debate.

Attanasio sees humanity as an exceedingly polymorphous species, at least in the potentials that hover before it now that we are on the verge of genetic engineering and artificial intelligence. Since we are also fractious, the various factions of any future humanity seem bound to be in conflict, and only the gods, offstage and superior, may remain aloof (mostly). Yet humans are also flexible. They can adapt to strange situations, and they can even switch factions, though in Attanasio's future, where those factions are based on technological transformations, they may need a bit of help.

What Attanasio is saying is worth hearing, and the novel held my interest well enough. But I did feel it was too strong on something that is perhaps best called *attitude*. There was a lot of posturing of the sort that makes me think of an overacted play. There were too many set pieces, too many characters acting from Attanasio's motives instead of their own. And while the result is undeniably impressive as a work of art, it feels not at all like a story drawn from some real future world—which is a flaw only if one thinks stories *should* feel that way.

According to his blurbs, Paul Park is even more of an artist than Attanasio, for his **Celestis** (published in England last year as *Coelestis*) is supposed to be challenging literary SF for the demanding reader. Unfortunately, though the novel is literary enough, Park insults the intelligence of the demanding reader very early on.

Since much of the book is good, let's get the insult out of the way first: *Celestis* is set on a distant world, tidelocked to its sun so it provides a classic dark side/light side/habitable twilight zone setting, much as we used to think was Mercury. People move between the planet's surface and orbit by means of a space elevator, and space elevators depend for their existence on there being a geosynchronous orbit, which does not exist if a planet's day is a year long. The pity is that the elevator plays absolutely no role in the story; Park could have deleted it easily, and he should have, for the sake of that demanding reader.

The story echoes Kenya in the days of the mau-mau. This world has natives, the culmination of a biosphere rooted in the chemistry of sulfur (like the seabottom ecosystems that gain their energy from magma-powered chemosynthesis rather than photosynthesis). They are humanoid but also utterly unhuman. When humans arrived, they took offense at native be-

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havior and their apparent enslavement by "demons," found chemicals to liberate their minds, and devised surgical procedures and implants to make them look human. Many of the natives accepted the new definition of the way things should be and struggled mightily to become proper humans, even learning to play the piano. Both humans and natives are also busily aping the ways of the British empire, long, long gone from an Earth smothering in people, disintegrating in chaos, abandoning its colonies.

The tragedy of the old colonial days was that Europeans were widely accepted as right and proper objects of emulation in Africa, India, Southeast Asia, South America. The result was a sort of identity crisis that began to resolve only when the various emulators began to rebel. In Kenya, that meant mau-mau "demons," white vigilantes, and so on. We see much the same in Park's tale, which begins as Simon, a young diplomat not long off the last boat from home, is sent to a lawn party. He is in bed with his host's daughter when the rebels attack and slaughter most of the humans, including his pillowmate. He becomes a prisoner, a hostage, along with Katherine, a native so thoroughly humanized that Simon finds it very easy to react to her as to a normal—and attractive—human girl. Yet she is now without her pills, and she is beginning to revert, to throw off the hitherto accepted mask.

Celestis is the tale of their captivity, the attack of the vigilantes, their escape, their encounter with the very last of the demons, the rising rebellion, their trek toward what Simon imagines must be safety at a coldside research station. It is also a tale of masks, with a conclusion that turns the whole thing into a critique of the colonial mind, whose own mask is the least changeable one of all.

Skip over the pages that mention that space elevator. The rest of the book is interesting, provocative, and worthy of your attention.

With **Orion Among the Stars**, Ben Bova brings us the sixth volume of the adventures of Orion the hunter, eternal hero, created by Aten (aka Apollo) to go back in time and wipe out the Neanderthals in order to assure the evolution of ourselves and our eventual godlike descendants, of whom Aten is one. Orion succeeded in that mission and several more, all serving the ends of a near-god who aims to become the chief of all the gods. Along the way, the goddess Anya fell in love with him and he with her. The other gods—especially the jealous Aten—tried to keep them apart. But Orion—strong, smart, resourceful, and immortal enough to belong to a Marvel comic book—persisted, and though the lovers were repeatedly sundered, they managed to keep coming together.

When Orion wakes this time, he is a far-future soldier assigned to lead an attack on a world held by ferocious giant felines, the Skorpis. Despite insuperable odds, he and about half his small force survive and even prepare to invade the Skorpis base. But then he learns the nature of the war in which he fights, one side led by Aten,

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the other by Anya, and if he dares to approach his love, says his Maker, she will blast him to atoms. He also learns of the Old Ones, ancient intelligences who disapprove of human violence and will—if humans dare to use their newest weapon, a star-destroyer—extinguish the species and all its allies, notably including Aten and his fellow would-be gods.

Orion has a task ahead of him, and his success is possible only because he has been gaining powers despite all Aten's most tyrannical intentions. That is, he's been growing up. Thus, like all children, he must somehow supplant—and even exceed—the father-figure, his Creator, Aten. He must also find some solution to the problem of violence, both for the Old Ones and for his troops, cloned and trained as soldiers only and kept in cryogenic storage between battles.

Of course, he succeeds—that's what superheroes do, after all—and of course, he still has Anya to find and save for an eternity of love. There will therefore be at least one more volume.

An interesting thought is that Aten, so hung up on the pride of creation and domination, does not know what he has truly wrought, nor how well it reflects on his true powers. But that's fairly typical of parents, isn't it?

Perhaps because Richard Calder lives in Thailand, he set his first novel, **Dead Girls**, there, to be colored by klongs and brothels and knock-off artists of a thousand sorts. The backdrop is chaos born of nanotech gone wild, used to construct "dolls" as models for Europe's fashion runaways, toys for rich folk, realistic sex machines for brothels everywhere. The Southeast Asian knock-off artists who now pirate clothing, books, tapes, and software (etc.) promptly put out imitation Cartier and Dior dolls. A kind of trade war followed as Europe sent off nanotech viruses designed to destroy the illicit competition, which promptly retaliated in kind. And one of those viruses became the "doll plague": transmitted by sex, it infects men who then pass it to their wives who then have children who in adolescence turn into dolls, sex fiends, blood-drinking technovampires eager to pass the nanovirus on and conquer the world, even though victory must mean their own extinction.

Europe is supposedly quarantined. England is in the throes of a plague of Humanity-Firsters who hunt down the dolls, even their own children, and slaughter them gruesomely, on TV. And in a refugee camp outside London, we see Ignatz and Primavera, just kids, he smitten, she doomed. They escape, showing the leakiness of the quarantine. She becomes a whore and assassin, he her aide and lover and victim.

And all this we learn only in bits and pieces as Calder proceeds. The tale opens with Ignatz trying to escape, being captured by his and Primavera's employer's minions, discovering American agents who want to interrogate the pair and fetch them back to England, and running scared once more. The maguffin is some understanding of the mess the world is in, how it got that way, the

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disaster looming, and finally of how hate and love ride through the night together. Calder states his theme near the end, like so: " 'This is the apocalypse: after thousands of years of sexual warfare the myths of battle have been distilled into a poison so concentrated that it has become flesh. We have dreamed dreams of dark women—receptacles of our hatreds, desires and guilts—and now we pay for our dreams with the hard coin of reality. Primavera has risen from the *atelier* of those dreams. She is the family secret . . . who for years bricked up in a secret room, has broken free to seek revenge. . . .' "

" 'I do love her,' I said."

Do I give away too much? No, for getting there is all the fun, and I fear it's a fun you might well miss without a roadmap such as what's above. Calder presents his tale in a blizzard of bizarre images and events that might well put you off, and he doesn't even try to have it all make sense until he's well along.

Does he succeed? I think so, despite appeals to trendy quantum fractal bafflegab that quite fail to convince. We know how to ignore that in favor of his really quite astonishing high-wire dance of ultimate technological vampires and reductio ad absurdum of the war between the sexes, not to mention racism and bigotry and other human follies.

Give it a try.

It has been so long since I last reviewed a Jo Clayton novel that the one I reviewed (*Skeen's Leap*) isn't even on the list inside the cover of the latest, **Fire in the Sky**.

So it's about time, wouldn't you say? Since Clayton tends to work in threes, this is the first volume of the Shadowsong trilogy, where Shadowsong is Shadith, the name given to that ancient inhabitant of the Diadem once worn by Aleytys. She is now in the flesh, a human woman with certain talents, a gifted harpist and singer who can learn new tongues with astonishing speed, sense other minds in her vicinity, and move small objects with the power of her thought. She is thus a natural choice to recruit when Aslan, an old friend, faces the task of saving a newly rediscovered planet whose inhabitants communicate in part (not entirely, despite the cover blurb) in song.

Saving? Beluchad's natives are of two species, one human, two millennia descended from a crashed colony ship, the other local, creatures that share features of both plant and animal, reproduce by budding, and end their lives as Eolt, hydrogen-filled gasbags, wise and full of song. These two very different peoples get along in remarkable harmony. Indeed, they could be a model for any peoples faced with similar problems of coexistence.

Unfortunately, Beluchad has been claimed by two corporate entities, the Yaraka and the Chave. The former are exploiters, but their aim is renewable commodities such as pharmaceuticals. The latter are looters, rapacious miners who kill intelligent beings for sport, especially when they explode in great gouts of flame, as do the Eolt. Ideally, Aslan and Shadith will get rid

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of both. Less ideally, they will get rid of the Chave.

Yet they are realistic. Aslan is an anthropologist who sees her mission as preserving enough of a culture to permit future generations—once they have reached the point of missing what exploitation cost them—to reclaim and reconstruct their heritage.

That's a nice touch. I liked it, for though that has not been how our own anthropologists have seen their mission, that *is* how much of the information they have collected has been used. Perhaps unfortunately, Clayton didn't think it enough for a story. The Chave must decide to sabotage the mission so that word of their atrocities cannot get out. The natives must mount a resistance mission that, despite the Chaves's advanced weaponry, effectively cripples them. And the good guys must win.

How does this become a series? Well, at the beginning Shadith was a student on University (yes, it's a whole world) who was itching to get away and restore a little passion to her life. At the end of the adventure, she realizes she has had so much fun that yes, she *will* take another old friend up on his invitation to become a secret agent, out once more to find fulfillment righting wrongs.

A superhero with a harp. Sounds like fun.

John DeChancie has earned a reputation for silliness with his series of Castle books—*Castle Perilous, Castle for Rent, Castle Kidnapped*, up to the latest, *Bride of the Castle*. Just as you would in the bookstore, I've looked at them briefly; perhaps unlike you, I concluded that his brand of silliness didn't seem much to my taste, and I didn't pay him much attention. So it's high time, and here's **Living with Aliens** in the mail, and what the heck, let's give it a shot.

Living with Aliens is a tale told by a young teen male, Drew Hayes, who has ambitions to be a writer. Or is it a tale? *He* says it really happened, from the moment when his family, tooling along a country road, is buzzed by a UFO, picks up a pair of hitchhikers, Zorg and Flez, takes them home, and gives them the spare room. They're a bit strange, they don't talk much, and they have a large duffel bag which turns out to contain an inflatable flying saucer. They take Drew out flarning (joyriding, making crop circles, disturbing couples parked in isolated spots) and feed him smart pills (they take stupid pills), after which his writing improves greatly. Not surprisingly, the neighbors notice that something funny is going on around and over the Hayes house, rumors fly, tabloid reporters show up, and the family winds up on a TV talk show whose host seems designed with malice aforethought. And then Blog shows up.

Once you accept DeChancie's premise, the story follows pretty logically, which is after all the key to a great deal of humor (think of P. G. Wodehouse or Thorne Smith). That is, he's working a time-honored vein, and yes, he does make his reader laugh, especially if that reader is young enough not to have heard the jokes before. ■

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BRASS TACKS

Comment on Stanley Schmidt's Editorial, January '95:
Scientific research is not a random walk into the unknown. I take exception to your editorial of January '95. Rather it is more like an elaborate but sturdy structure built slowly and reinforced by repeated developments in related areas. While the fringes can be exciting and can produce surprising results, ultimately these discoveries are cast back against the overall framework which then strengthen the overall building.

Launching too deeply into unknown areas are not only unlikely to produce any valuable results, the odd discovery, lacking any firm foundation, is unlikely to evolve into a useful technology. Consider your example of the semi-conductor. If happened upon in the eighteenth century, before a more modern understanding of chemistry such a discovery, if confirmed, would likely have remained a laboratory curiosity until the theoretical framework developed. Even such "radical" paradigms as quantum mechanics was in the '20s, were not born overnight. An ever increasing number of unexplainable phenomenon at the fringe of measurement. Q.M. was successful not because it contradicted existing classical mechanical doctrine but because it enhanced it. The odd paradoxes to c.m. came somewhat later after the full implications of the q.m. paradigm had been examined.

Cold Fusion is probably an excellent example of bad science. Ignoring all the failed attempts to reproduce the data for the moment; let us assume that the phenomenon is real. The consequences are rather startling. It means our carefully developed understanding of coulombic and nuclear forces are nearly entirely in error. No discovery in recent times, not even quantum mechanics, was as devastating. Basic notions of energy conservation are likewise thrown in disarray. The photoelectric effect, the ultraviolet catastrophe and other "problems" which could only be satisfied by the development of quantum mechanics never threatened the foundation of these scientific principles. Electrostatic forces and energies are orders of magnitude away from their counterparts in the nuclear regime.

The history of scientific research shows that while the outer shell is often torn away and rebuilt by new discoveries, real progress occurs slowly and incrementally. The new models and ideas ultimately tie into this carefully built framework. The cross con-

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nections between different fields of study reinforce or weaken the lattice and lend to a more unproductive research.

PAUL B. BEEKEN

Your picture is generally true, but ignores some important points. You may turn out to be right that cold fusion is an example of bad science, but it is certainly *bad science to assume that no further investigation is warranted because you suspect that. You jump too far for conclusions about what the results would mean if they're real, but if they are, it's not inconceivable that some foundation-rebuilding* will *be necessary (though not necessarily to the extent you assume). In any case, to ignore results that* may *be real, particularly when they show* some *evidence of reproducibility, would be folly.*

Dear Stan:

After reading "Tide of Stars" by Julia Ecklar in the January *Analog*, I had to comment/question a couple of items.

I got the impression that Ms. Ecklar was trying to imply that there was relatively little weather activity on the planet beyond the "stiff west wind" mentioned at the beginning of the story, and an implication that there was also very little, if any, tidal or convective activity in the Odarkan Sea. In my experience with (Terran) weather phenomenon, two factors that influence weather are planetary rotation and temperature differentials. Therefore, there *should* be some sort of weather variations, and also, with three moons, some sort of tidal activity. Both of these factors should have produced some sort of "mixing" activity in the oceans at some level. This should have been enough to produce some sort of both currents and stratification.

On another subject, how does one "tack" a free/hot air balloon? No mention is made of a propulsion source, yet the balloon is directed in some manner. This is puzzling. I wish she had at least mentioned some sort of controlling power other than buoyancy. It would have made "suspension of disbelief" somewhat easier.

Other than that, the story is an excellent one, and one that I couldn't put down till I had finished it.

BRAD LEVY

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The author replies....

Mr. Levy raises a good point in his letter when he questions the requirements for staging a planetary anoxic event. In fact, before doing the research for "Tide of Stars," I would have questioned the likelihood of such an ocean-wide occurrence, too. (I shall come clean here and admit that it was geologist-friend Karen Rose Cercone who suggested the concept of oceanic anoxia when I grumbled, "I need a natural way to waste an entire ecosystem." Once I found out that the phenomenon was real, though, it was just too bizarre and interesting not to use.)

Planetary rotation and lunar tidal stresses certainly contribute to the mixing of oceanic water. However, by

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far the strongest influence on water movement is thermal gradients (the tendency of warmer water to rise and colder water to rush in where the warm water used to be). If the blowing of wind across the water's surface was enough to prevent stagnation, lakes, bays, and inland seas wouldn't "turn over" with such (geologic) frequency. Wind and tidal stress can contribute to temperature differentials down to a few feet below the water's surface, but it's really the presence of polar ice caps that causes the cooling of very, very deep water that's needed to produce things like the California current and the Gulf counter-current. And it's *those* currents that drag the cold polar water across the bottom of the ocean and stir things up nice and good.

Minor anoxic events have occurred even in modern times (the recurrent buildup of hydrogen sulfide in the deeper sections of the Baltic Sea being one example that springs immediately to mind). But even ocean-wide events such as the one described in "Tide of Stars" have happened right here on our own planet within the last 100 million years—more than once, in fact.

The high organic carbon content in mid-Cretaceous ocean sediments (along with other indicators) reveals at least two time envelopes during which the water in Earth's oceans contained insufficient oxygen to rot organic matter. Geologists speculate that these oxygen deficits were intensified due to a lack of strong oceanic mixing because of the composition of the oceans at the time, and because the greenhouse environment on mid-Cretaceous Earth prevented the development of oceanic thermal gradients (because Earth had no ice caps).

Now, oceanic anoxic events weren't restricted to the Cretaceous, but it did have two in fairly rapid succession—within 10 million years of each other—which even geologists admit is pretty unusual. That's why I chose the Cretaceous as the model for Uriel's geology and climate. That, and the fact that an advanced greenhouse environment *does* have a tendency to "even out" weather so that a planet doesn't suffer the dramatic storms associated with the *transition* to greenhouse conditions.

Just to avoid the question of how much effect lunar tidal currents would have on oceanic mixing, I intentionally referenced Uriel's three natural satellites as "puny" and "tiny" within the text of the story. Whether that meant they were physically tiny or just far removed from the planet wasn't really important—all that mattered was that they couldn't have produced as much stress as Earth's Luna. You have to remember that (judging from the rest of our Solar System) Luna is exceptionally large when compared to the size of the planet it orbits. Three much tinier moons, not necessarily all tugging in the same direction (and, therefore, probably canceling out each other's tidal effects most of the time) would almost certainly have less effect than our local monster. And even Luna wasn't enough to rescue Earth's oceans from anoxia without ice caps to help it.

As with anything in a science fic-

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tion story, there were some simplifications that had to be made when the basic gist of the situation was explained, details that had to be left out. For example: Uriel's oceans won't all go over on exactly the same day, belching up hydrogen sulfide and methane from every deep-water location as though someone has thrown a switch. Bays and basins will roll over in fits and starts, with large portions of the open ocean probably never overturning at all (in Earth's past, the later development of icecaps eventually created deep currents that could mix those bottom waters without requiring a catastrophic turnover). Likewise, when the ocean starts throwing up its deadly gasses, not everything in the water will be killed, not everything on the planet's surface will die. (There's still life on Earth, after all.) But sweeping mass extinctions such as marked the end of Earth's Cretaceous Era will take their place in Uriel's geologic record, as well, and the shape of Uriel's evolution will be determined by whatever life is left behind.

JULIA ECKLAR

Dear Stan,

I enjoyed Julia Ecklar's "Tide of Stars" in the January '95 issue, and one of her story props has raised some questions.

I've been crewing for hot air balloons for five or six years now. Pilots won't launch in winds over about five mph because the balloons are difficult to inflate (the wind tends to squash the envelope DOWN) and if the inflation is successful the balloon's enormous sail area makes it very difficult to control and hazardous to launch. Landings in wind have similar problems. Another thing is that balloon pilots rarely fly between 10 A.M. and late afternoon because the Sun-warmed Earth produces thermals resulting in bad control and undesired lift to undesirable altitudes. They speak of the air as getting "squirrelly." Finally, when a balloon is in the air it moves with the wind. Consequently, to passengers in the gondola, there is no relative wind. The air feels still unless the balloon moves vertically through a horizontal shear.

At the beginning of the story we are presented with an unpowered hot air balloon in what seems to me to be *very* rough weather. I invite Ms. Ecklar's comments.

I will be fair: only a page later a silent engine is "engaged." A powered balloon is an airship. I've never worked with an airship and don't know their frailties and abilities. Still, it seems there would be many similarities.

If Ms. Ecklar is interested in more information about aerostats, a good source is the Balloon Federation of America, PO Box 400, Indianola, Iowa 50125.

J. GLAZER

P.O. Box 31
Horse Creek, CA 96045

The author replies....

Mr. Glazer was right when he speculated that I was trying to indicate an engine-powered airship, rather than a free-floating balloon (thus the reference to an engine/propulsion system

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on pages 15 and 18). I'm sorry if my not using the word "airship" made this confusing.

I was picturing the balloon portion of the airship as nothing more than a lift—trying to imply that nothing which "pushes" against the ground was being used to keep the airship aloft, in deference to Uriel's environment. As far as Feles Sadena was concerned, whether or not such a "pushing" lift device would actually have done any damage to the ocean's surface wasn't as important as whether or not his tourists *believed* the balloons were more ecological. So other than the relatively low-tech hot-air lift, I assumed the "balloons" were equipped with plenty of other non-balloon-like equipment, for the convenience of the pilots.

I do wish I'd known the term "squirrelly" when I was writing "Tide of Stars," though—I'd have certainly had some character use it!

JULIA ECKLAR

Dear Stan:

Analog dependably contains the best *science*-fiction, as far as I've been able to discover, of any prozine now being published, but Daniel Hatch's "In Forests Afloat Upon the Sea" (January, 1995) must have set JWC, Jr. spinning, and even punched my "Disbelieve!" button (which isn't easily activated, in the fiction context). This is especially regrettable because Hatch tells a story very well, and I enjoyed this one, but. . . .

The concept of a civilization supported on large, floating, vegetation-covered raftlike islands on a planet almost entirely covered with oceans is ingenious, but Hatch presents it with too little science-fictional imagination and too much reliance on the reader's (or at least this reader's) ability to ignore (or ignorance of) basic science and mechanics.

Given the major ocean currents, storms and technology presented, such large rafts couldn't possibly hold together long enough to produce the mature trees and the social stability described. The idea of using pumice—about the only solid mineral material available in such an environment, because floating chunks can be gathered from the surface of the water—as the basis for the soil on these rafts is brilliant, but pumice weathers rapidly (on a geologic time scale) and if it's that abundant there must be substantial volcanic activity (not mentioned in the story) to produce it; so much volcanism would imply the formation of mountains and significant land masses.

What finally triggered my inability to suspend disbelief was the technique of executing murderers by fastening them to a hollowed-out log filled with finely-ground pumice and (supposedly) drowning them when this was pushed into the ocean. Having worked for thirty years with pumice (both artificial and natural) as a constituent of greenhouse and potting soils, I do understand that this material (actually a form of obsidian or volcanic glass transmuted to a sort of foam when, in a semi-molten state, the pressure on it is suddenly and greatly reduced) does indeed have a specific gravity, in the finely-pow-

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dered form, more than that of water. But not *much* more (there are still microscopic bubbles of air trapped in the small particles), and almost certainly not enough to cause the hollow log encasing them to sink. (A few known woods do sink in water, but this very denseness makes them too difficult to work for the described use to be practical.) Hatch's idea is ingenious, and I especially like the concept of treating unprovoked warfare as murder, but he (or the editor of the story) really should have devised some other method of execution.

Given the powerful ocean currents and storms described one must assume a large temperature differential between the polar and equatorial regions, and the free-floating islands apparently are often carried quite far from the tropical and semi-tropical regions—which makes the survival of lemon trees (no matter how useful their fruit may be to prevent scurvy) somewhat problematical, and I'm not sure this was explained adequately.

Then there's the suspicion that the society depicted would need to have developed a strong encouragement of the hard-wired human pubertal wanderlust, for genetic reasons, and probably the protagonist's mother's desire that he not leave the community should have had less weight than it was given—but that's sociology (not really science), and an even more minor quibble than the others.

Julia Ecklar's fine "Tide of Stars," on the other hand (perhaps because it deals with sciences of which I'm almost totally ignorant), presents a potential threat to humanity beautifully, by leaving the reader to deduce it. Yes, if "The Greenhouse Effect" does continue to develop on Earth, we probably will—after drastic climatic changes which will more than decimate our population in the next fifty years or so (much of the world's food comes from large areas in the U.S. and ex-Russia where the reduction of annual precipitation by just a few inches will be disastrous)—be faced with the overwhelming problem of low-oxygen sea water and the anaerobic production of noxious gases.

Your editorials are always stimulating, and almost always eminently sensible, but I'd like to especially commend the one in this issue (January 1995). As you say, the growing trend to fund research only in sure-fire, high-profit subjects is distressing and potentially disastrous. Especially frightening is the growing trend for universities to derive more and more of their income from commercial sources (which can patent the results of the research they commission, even though the university is government-sponsored)—this is, of course, almost always works in areas where a high and immediate profit can be easily expected. There may or may not be a lot of Genuine Scientific Breakthroughs left to be made, but it looks as though they'll be more sparse than they need to be, in the U.S., if this pattern continues. Thanks for bringing this to our attention, even though there doesn't seem to be much we can do about it.

DON FITCH

Covina, CA ■

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29 Sep-1 Oct

RISING STAR 4 (Virginia SF conference) at Salem, Va. Guest of Honor—Frederik Pohl, Artist Guest of Honor—Frank Kelly Freas, Special Guest—Hal Clement. Registration: $17.50 until 1 August, $20 at the door. Info: Rising Star 4, 545 Howard Drive, Salem VA 24153. (703) 389-9400.

6-8 Oct

ARMADILLOCON 17 (Austin SF conference) at Red Lion hotel, Austin, Tex. Guest of Honor—Alexander Jablokov, Artist Guest of Honor—Vincent di Fate, Fan Guests of Honor—Dick & Leah Zeldes Smith, TM—Terry Bisson. Registration—$25 until 30 September. Info: ArmadilloCon, Box 9612, austin TX 78766. (512) 835-9304.

29 Aug-2 Sep 1996

L.A.CON III (54th World Science Fiction Convention) at Convention Center, Hilton, and Marriott Hotels, Anaheim, Cal. Guest of Honor—James White; Media Guest of Honor—Roger Corman; Fan Guests of Honor—Takumi and Sachiko Shibano, Special Guest—Elsie Wollheim, TM—Connie Willis. Registration—$90 until 30 June 1996, $110 until 31 December 1995, then higher. Child-in-tow (3-12 in 1996)—$35, infants—free, Supporting—$30. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Join now and get to nominate and vote for the Hugo Awards and the John W. Campbell Award for Best New Writer. Info: L.A.Con III, %/ SCIFI, Box 8442, Van Nuys, CA 91409. lacon3-info@netcom.com

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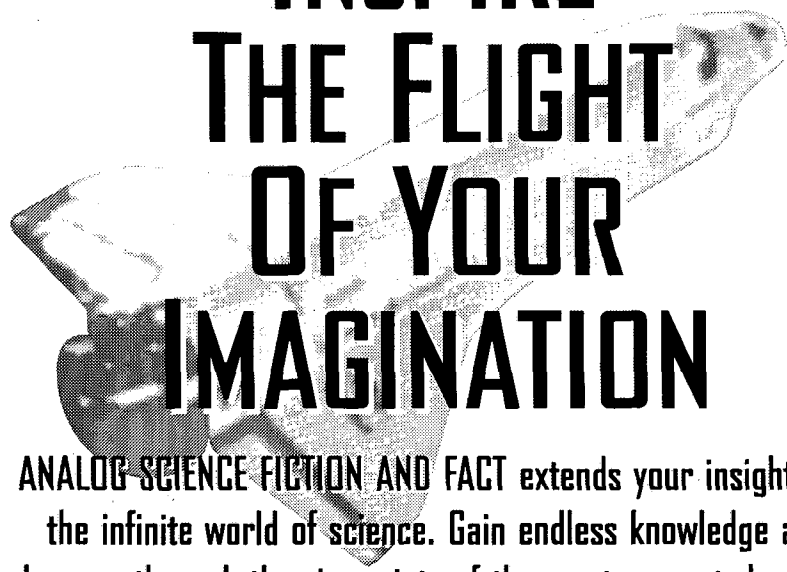

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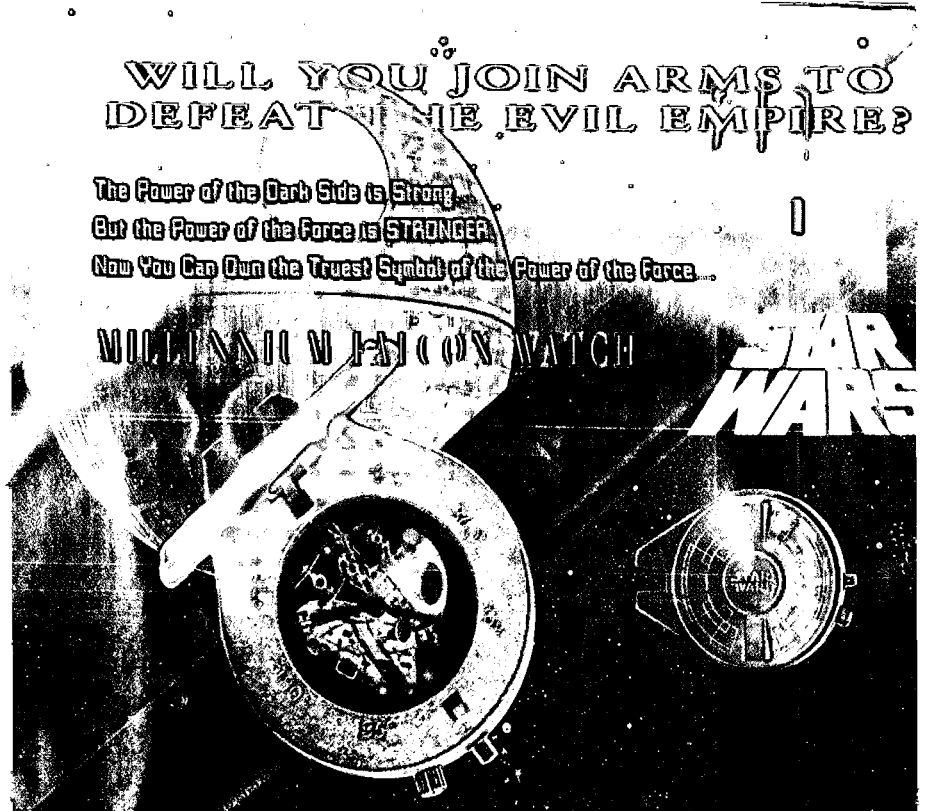

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